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# CONTENTS

## No. 1, First Quarter, 1937

[Issued June 16, 1937]



## No. 2, Second Quarter, 1937

[Issued Aug. 31, 1937]

## No. 4, Fourth Quarter, 1937

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# The Philippine Journal of Agriculture

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## A STUDY OF DIFFERENT SPECIES OF AGAVE [1]

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Maguey has been produced on a commercial scale in the Philippines since the early part of the twentieth century but other allied species of Agave have barely come into prominence. The defunct Bureau of Agriculture introduced sisal in 1905 from Hawaii and considerable attention was taken in its cultivation but up to the present only patches of ground planted to sisal may be found here and there. Henequen had been brought here from Mexico but its cultivation is still left on an experimental scale. Like maguey these species of Agave have been found suitable under our soil and climatic conditions. With improved preparation of the fiber by the use of modern machinery and a better market price for the product, this crop will eventually be widely grown in our principal fiber-growing provinces. There is no doubt that during typhoons, droughts and other calamities causing a decrease in our cereal production, these species of Agave will be found good as emergency crop.

The Bureau of Plant Industry in an attempt to popularize these species of Agave and revive the interest on the growing of these crops conducted experiments on the different species which are the subject of the present work. This paper is an endeavor to classify the five species of Agave and to determine their comparative merits under field conditions at the Lamao Experiment Station, Limay, Bataan.

[1] Conducted at the Lamao Experiment Station, Limay, Bataan.

DESCRIPTION OF DIFFERENT VARIETIES

Maguey, *Agave cantala* Roxb.—Introduced into the Philippines from Mexico. Commercially grown in Java and British India. May be planted either by suckers or bulbils. When planted by suckers the first crop may be obtained in three years and from bulbils about a year later. It does not develop a real trunk. Produces from 156 to 185 leaves per plant. Leaves grayish-green, long, wavy, with terminal and marginal spines and measuring on the average 170.24 centimeters long and 6.58 centimeters wide. Fiber white, fine, about 113 centimeters long and may be extracted by retting and stripping. Largely used for rope making and for other tying purposes. The Philippine product in the market is known as "Manila maguey," "Manila Aloe," and "Philippine maguey."

Sisal, *Agave sisalana* Per.—Introduced into the Philippines by the Bureau of Plant Industry in 1905 from Hawaii. Widely grown in Java, East Africa, India, and Bahamas. When planted by bulbils the first crop may be obtained in about four years' time. Like maguey, sisal does not develop a real trunk. Produces from 148 to 178 leaves per plant. Leaves green, wide, rigid and with terminal spines. Marginal spines partly or totally absent. Leaves measuring on the average 131.26 centimeters long and 8.57 centimeters wide. Produces polls from six to eight years. Fiber white, coarser and stronger than maguey. In commerce the fiber is known as "sisal" preceded by the name of the country producing it.

*Henequen, Agave fourcroydes* Lem.—Introduced from Puerto Rico. When planted by bulbils the first crop may be obtained in about four years' time. Producing from 112 to 124 leaves per plant. Leaves green, long, rigid, with terminal and marginal spines and measuring on the average 103.99 centimeters long and 8.34 centimeters wide. Fiber of a dull white color, quite long measuring about 110 centimeters. In the market the fiber is known as "sisal" or "Mexican sisal." Fibers largely used for binder twine.

Zapupe, *Agave Zapupe*.—Introduced from Mexico in 1905. Grown first at La Carlota, Occidental Negros, in 1912, where the Lamao materials were obtained. Very much like Henequen in habit of growth. Produces from 73 to 106 leaves per plant. Leaves green, shorter than Henequen, rigid, with terminal and marginal spines and measuring on the average 96.77 centimeters

long and 7.14 centimeters wide. Fiber white, quite short, measuring only about 83 centimeters long.

*Agave sp.*—Introduced probably from Puerto Rico. Good for ornamentals producing small and pale green leaves closely set at the trunk. The leaves on the average are 46.28 centimeters long and 6.26 centimeters wide and provided with marginal and terminal spines. This species of Agave produces the shortest and whitest fiber. The fiber is rather coarse measuring about 72 centimeters long.

## EXPERIMENTS AND RESULTS

*Variety test.*—On a fairly uniform land a variety test of the above species of Agave was begun on June 12, 1923, using maguey as check. One hundred seventy-two suckers from each species were planted excepting in the case of Agave zapupe and Henequen of which only 96 and 28 suckers were planted respectively. The distance of planting was 1.5 meters apart each way. Both ends of the field were planted with maguey as checks. The layout of the experiment plots may be diagrammatically represented as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| Maguey Check 1 | Sisal | Agave sp. | Maguey (Test) | Henequen | Agave zapupe | Maguey Check 2 |

All plots were weeded twice every year. The first harvest was made in 1928 and yearly thereafter. Only mature leaves from five individual plants of each species were harvested to determine the yield. The fiber was extracted by retting the leaves in water for 15 days and then beating them until all the pulps were removed. Then the fiber was sun-dried and weighed.

The following table shows the data obtained from 1928 to 1931 inclusive:

TABLE 1.—*Showing the annual and average yields*

| Variety name | 1928 | 1929 | 1930 | 1931 | Yearly average |
|---|---|---|---|---|---|
| | *Kilos* | *Kilos* | *Kilos* | *Kilos* | *Kilos* |
| Sisal | 4,430.22 | 1,897.588 | 4,932.84 | 7,521.47 | 4,695.454 |
| Agave sp. | 1,235.55 | 244.42 | 2,266.44 | 4,215.134 | 1,740.384 |
| Maguey | 4,106.66 | 1,879.812 | 6,443.80 | 6,619.338 | 4,762.400 |
| Henequen | 1,068.44 | 1,248.764 | 4,915.064 | 4,335.122 | 2,891.840 |
| Agave zapupe | 2,615.60 | 697.708 | 5,577.220 | 3,472.986 | 3.090.878 |

*Stripping and retting test.*—It was the object of this experiment to determine the comparative percentage of fiber of the above species of Agave by stripping and retting. A known quantity of leaves from the above species of Agave was weighed, knife stripped and subsequently dried in the sun. The weight of the sun-dried fiber was then taken and from this the percentage of fiber was obtained.

In the case of the latter, a known quantity of the leaves was harvested and weighed. Then the leaves were slit into strips, bundled and soaked separately in salt, semi-salt, and fresh water. At the end of 15 days the bundles were removed and beaten until all the pulps were taken away. Then the fiber was washed and dried in the sun and from the weight of the sun-dried fiber the percentage of fiber was calculated. The following table shows the results obtained:

TABLE 2.—*Showing the percentage of fiber by stripping and retting*

| Variety name | Knife stripped fiber | Salt-water retted fiber | Semi-salt water retted fiber | Fresh water retted fiber | Average |
|---|---|---|---|---|---|
| | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Per cent* |
| Maguey | 1.50 | 2.84 | 4.11 | 11.74 | 6.32 |
| Sisal | 2.46 | 1.56 | 1.93 | 3.43 | 2.30 |
| Henequen | 1.80 | 2.12 | 3.70 | 1.92 | 2.58 |
| Agave zapupe | 3.00 | 7.50 | 2.40 | 6.00 | 5.30 |
| Agave sp. | 2.00 | 1.25 | 6.40 | 2.66 | 3.43 |

## DISCUSSION

Table 1 shows that maguey (Agave cantala) from the average of four years' test yielded 4,762.40 kilos of fiber, the highest among the five species of Agave under study. Sisal (Agave sisalana) yielded 4,695.454 kilos, the second highest yielding in the group. Agave zapupe was the third ranking variety giving an average yield of 3,090.878 kilos of fiber per hectare. Henequen (Agave fourcroydes) and Agave sp. yielded 2,891.84 and 1,740.384 kilos of fiber, the fourth and lowest yielding varieties.

As may be seen from the above results, the individual yield varies from year to year. In the case of maguey the yearly yield for a period of four years were: 1928—4,106.66 kilos; 1929—1,879.812 kilos; 1930—6,443.8 kilos; and 1931—6,619.338 kilos. This is principally due to varieties and secondarily to climate.

The annual rainfalls during the period of four years were as follows: 1927, 119.71 inches; 1928, 106.25 inches; 1929, 112.19 inches, and 1930, 108.29 inches. The comparatively low yield in 1929 may be due to a low precipitation in 1928 (106.25 inches) which probably affected the 1929 crop. Again the yield in 1928 was comparatively high which must have been due to the high rainfall in 1927 (119.71 inches). In this connection, it may be added that yield determination was done in all cases from January to February of each year so that the crop for that year was affected by the rainfall of the year just preceding.

From the results of the stripping and retting tests shown in Table 2 it is very evident that excepting the case of sisal, retting gave a decided advantage over stripping as far as the percentage of fiber obtained is concerned. In the case of maguey the average of retted gave 6.32 per cent fiber as aginst 1.50 per cent of the knife-stripped. Also, in the case of Henequen, the advantages of Agave zapupe and Agave sp. go with the retted, the percentage of fiber obtained being more than the knife stripped.

## SUMMARY

1. Five different species of Agave, namely, Agave cantala, A. sisalana, A. fourcroydes, A. zapupe and Agave sp. have been described in this paper.

Maguey, *Agave cantala,* produces a long fine white fiber known in commerce as "Manila maguey," "Manila Aloe," and "Philippine maguey."

Sisal, *Agave sisalana,* produces a coarse white fiber known in the market as "sisal."

Henequen, *Agave fourcroydes,* otherwise known as "Mexican sisal" produces a coarse white fiber like sisal but stronger.

Zapupe, *Agave zapupe,* resembles Henequen in habit of growth but is generally smaller than the latter. It produces a white fiber less than a meter long.

*Agave* sp. is an unidentified species of Agave which produces the whitest but, the shortest fiber.

2. The yield of the above species of Agave was influenced by the annual rainfall—a factor which caused a distinct variation in the increased yield of the following crop.

3. Retting gave a decided advantage over knife stripping in that more fiber was obtained in the former method. Maguey,

zapupe and Agave sp. gave the highest average percentage of fiber in both methods.

4. On the strength of the evidence presented in this paper it may be concluded that the two species of Agave that are decidedly the best are maguey and sisal.

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# EFFECTS OF VARIATION IN MOISTURE CONTENT OF SANDY LOAM SOIL IN POTS UPON WRAPPER-LEAF TOBACCO

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THREE TEXT FIGURES

The results of investigations reported by Montgomery and Kisselbach (1912), Briggs and Shantz (1913–1914), Kiesselbach (1916), Miller (1916–1923), and Thom and Holtz (1917) show no relationship between the ability of a plant to withstand drought and its water requirement. On the other hand an increase of the water content of the soil affects the quality of produce obtained from the crop. Tatcher (1913) showed that there was a decrease in protein content of wheat in eastern Washington with an increase in rainfall. Greaves and Carter (1923) also observed a decrease in the nitrogen content of wheat, oats, and barley as the irrigation water used in their growth was increased. Further in 1924, Neidig and Snyder noted that under field conditions as high moisture content properly distributed during the growing season in an average soil produces a high yielding wheat with a low protein content. So far no experiment of this kind has been tried on tobacco.

The extent to which the growth of tobacco plants and the quality of the leaves produced as affected by soil-moisture had been the subject of study of the Ilagan Tobacco Experiment Station. The plants were grown in soil contained in petroleum cans. In the absence of a suitable shelter-house or greenhouse to protect the plants from rain, the cultures were placed under the side-shade of the warehouse building. Under this condition, the plants were grown under partial shade. The results obtained were encouraging but the study was discontinued due to lack of necessary shelter. However, it was again taken up at the Central Experiment Station, Manila, immediately after the greenhouse of the Tobacco Research Section was built.

The results secured under controlled conditions confirmed in general the trend of data secured at Ilagan. Hence, only the

findings gathered at the Central Experiment Station are here reported. The former records are kept on file in the Tobacco Research Section for reference.

The tobacco plants were grown in big bondex cans capable of holding 55 kilograms of ordinary air-dry-sandy loam soil and placed in the greenhouse. The experiment was conducted in duplicate cultures and repeated twice at different seasons of 1935 and 1936.

## MATERIALS AND METHOD

*Preparation of seedling.*—Seeds of Ilagan Sumatra variety were sown in soil contained in seed boxes. When the seedlings were 28 days old they were pricked to another seed-bed previously prepared and allowed to remain there until they were 60 days old. At the time of transplanting the seedlings to the Bondex cans, they averaged 10 cm. high with 5 well developed leaves and had an average total leaf product of 254 sq. cm.

*Soil used.*—Enough sandy loam soil to fill 20 bondex cans 34 cm. in diameter and 50 cm. in depth were collected at the Central Experiment Station field. The soil was spread to dry in the greenhouse until its constant air-dry weight was obtained. The soil was thoroughly mixed previous to filling the containers with it. Each can contained 55 kilograms of air-dry soil.

*Preparation of various constant soil-moisture.*—The average of three trials showed that 55 kilograms of air-dry-sandy loam-soil when placed in a Bondex can required 19 liters of water to saturate it. This state of wetness was considered as 100 per cent saturation. This volume of water (19 liters) was used as the basis in the calculation for the different soil saturations as 90, 80, 70, 60, 50, 40, 30, 20 and 10 per cent. Thus, in the 90 per cent saturation, the amount of water added to the soil was 17.1 liters (19 liters $\times$ .90 $=$ 17.1 liters). The others were prepared similarly. In the 10, 20, 30, 40, 50, 60 and 70 per cent saturations the water added to the soil to make the necessary saturation was not poured directly on the soil in the bondex can. The soil was removed from the container and spread on a cement floor. Then the amount of water required to make the desired saturation was sprayed and mixed thoroughly with the soil after which the moistened soil was returned to the can. This operation was necessary especially in the 10 and 20 per cent saturations because the amount of water to be added was too little, and if poured into the can

directly only the upper layer of the soil contained in the can could be made wet while the lower ones would remain dry. Consequently, the degree of wetness of the medium would not be homogenous.

*Method of watering the plants.*—One of the greatest difficulties experienced in growing plants in large containers is to replace evenly throughout the soil the water that has been removed by the plant. To remedy this situation a modification of the method of Miller (1916–1923) was devised as shown in Fig. 1. By means of a soil tube three cylindrical masses of soil 5 cm. in diameter and 25 cm. in depth were removed from the upper portion of the soil. These cavities were then filled with fine gravels and coarse sand. When the plants were watered, the water was poured into these cavities and allowed to diffuse throughout the soil.

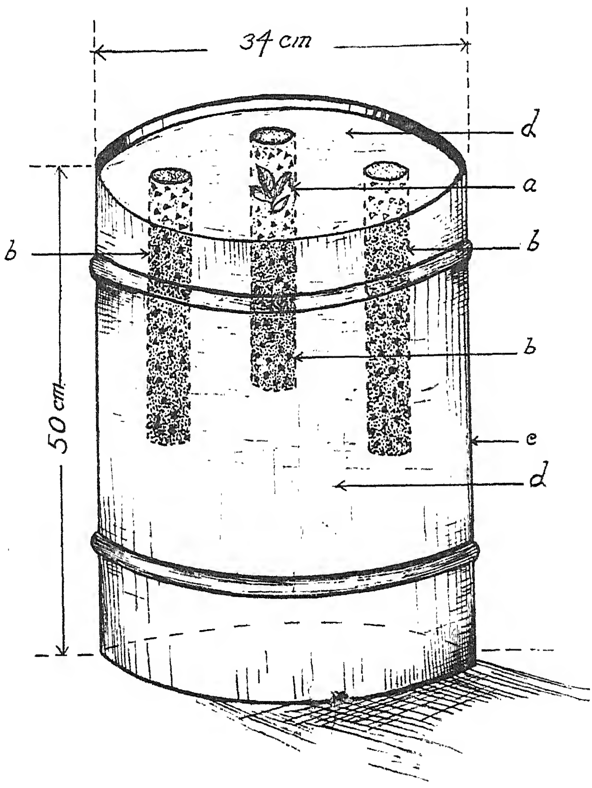


FIG. 1. Diagram showing method used in growing tobacco plant in soil contained in large containers. *a*, plant. *b*. sand and gravel. *c*, metal container. *d*, soil.

The plants were placed in rows in the greenhouse and weighed every other day. The lost weight through soil surface evaporation and transpiration was regained by adding enough water to bring back the weight of the culture to its original weight. Hence, the soil-moisture in each can was practically kept constant throughout the life of the tobacco plant.

*Growth measurement.*—At frequent intervals from the date of transplanting to the time of first priming on November 21, the length of each leaf was obtained from the axil of the leaf to the tip of the lamina, and the width was taken at the widest part of the leaf. Every time leaf measurements were made, dried or yellow leaves and the young leaves shorter than 2 cm. long were not included. Determinations of actual leaf areas were not made, but the leaf product was employed. This is an index obtained by multiplying the length of the leaf by its width; it represents approximately the true leaf area. The leaf products were used to indicate the relative vigor of the different set of cultures at different stages of the development of the tobacco plant. The breadth index was obtained by dividing the width of the leaf by its length and the quotient multiplied by 100. The total height of all the plants was taken on December 10. The height of the plants that flowered was measured from the ground to the tip of the inflorescence and the height of those that did not flower was observed from the ground to the axil of the youngest visible leaf.

*Determination of burning quality.*—After the leaves had been cured, strips one centimeter wide were cut crosswise at the middle of the leaf from both sides of the lamina. The strips were placed in separate envelopes and dried in the oven at 60° C. for a period of one week. Later they were transfered to a desiccator to cool. With the use of a burning alcohol lamp, the tobacco strips were ignited and the length of time the strips kept glowing was recorded. There were one hundred determinations taken from each set of plants but only the average of these figures is reported here.

*Samples for chemical analysis.*—Sufficient and representative leaf samples from each set of plants were taken and submitted to the Agricultural Chemistry Section of the Bureau of Plant Industry for analysis. Following the official method of pro-

cedure the following were determined: ash content, total nitrogen, nicotin, and color of ash.

## RESULTS

The average growth measurements of the plants (leaf products) in two separate trials are given in Tables 1 and 2 and shown graphically in Figure 2. The harvest data are also tabulated, Tables 3 and 4, and graphed as shown in Figure 3. Table 5 shows the chemical analysis and quality of leaves harvested from plants grown in various constant soil-moisture.

For the sake of clarity the results of this study are discussed under three headings. The effect of various constant soil moisture upon the rate of growth of the plant is given first, then its effect upon the final make-up of the plant, and finally, its effect upon the chemical content and quality of the crop produced.

### EFFECT OF SOIL-MOISTURE UPON THE RATE OF GROWTH

An examination of Tables 1 and 2 and particularly of the graphs in Figure 2 shows that the amount of moisture in the soil has a profound effect upon the rate of growth of tobacco plants. Insufficient amount of soil-moisture as well as too much water in the medium both retarded the rate of growth of the plants. Very rapid growth was noted under greenhouse conditions when there was ample moisture and air supply in the medium. This state of condition was attained when the per cent saturation of the soil ranged between 60 and 70.

If the plant which had the biggest leaf product observed on September 12 be given a value of 100, the relative value of the rate of growth of the different cultures beginning from the lowest per cent saturation to the highest would be: 49, 79, 93, 96, 99, *100*, 99, 91, 80 and 63. The plants in the 60 per cent saturation grew the fastest. The leaf product increased from 254 sq. cm. to 330 during a period of one week from date of transplanting. Those plants grown in the 50 and 70 per cent saturations were close second (Table 1). At 10 and 100 per cent saturations the lower leaves of the plants died which resulted to a reduction in leaf area. The leaf area of green leaves was reduced to 36 per cent in the former and to 18 in the latter.

Another growth measurement of the plants was taken six days later (September 18). When graphed (Fig. 2) the trend

TABLE 1.—*Results of first trial showing average total leaf products in relative values of tobacco plants grown in soil of various constant soil-moisture observed at different periods of growth development*

| Per cent saturation | Period of observation | | | | | |
|---|---|---|---|---|---|---|
| | September 12 | September 18 | September 25 | October 4 | November 8 | November 21 [a] |
| 100 | 63 | 40 | 24 | 18 | 15 | 13 |
| 90 | 80 | 79 | 62 | 52 | 44 | 43 |
| 80 | 91 | 91 | 89 | 83 | 71 | [c] 70 |
| 70 | 99 | 99 | 98 | 97 | (6,893 sq. cm.) 100 | (7,156 sq. cm.) [b] 100 |
| 60 | (330 sq. cm.) 100 | (767 sq. cm.) 100 | (1,908 sq. cm.) 100 | (4,089 sq. cm.) 100 | 99 | [b] 99 |
| 50 | 99 | 93 | 91 | 89 | 85 | [c] 84 |
| 40 | 96 | 85 | 82 | 79 | 68 | 66 |
| 30 | 93 | 76 | 69 | 64 | 54 | 52 |
| 20 | 79 | 62 | 50 | 47 | 38 | 35 |
| 10 | 49 | 37 | 31 | 29 | 26 | 25 |

[a] After the leaves were measured on November 21, the first four lower leaves from each plant were harvested.
[b] On November 19, flower buds appeared.
[c] On November 21, flowers buds appeared.

TABLE 2.—*Results of second trial showing leaf products in relative values of tobacco plants grown in soil of various constant soil-moisture observed at different periods of growth development*

| Per cent saturation | Period of observation | | | | | |
|---|---|---|---|---|---|---|
| | December 26 | January 3 | January 10 | January 26 | May 6 | March 19 [a] |
| 100 | 76 | 63 | 35 | 25 | 21 | 20 |
| 90 | 85 | 79 | 70 | 50 | 44 | 41 |
| 80 | 93 | 85 | 80 | 75 | 72 | [a] 69 |
| 70 | 99 | 98 | 97 | 98 | (8,509 sq. cm.) 100 | (9,066 sq. cm.) [b] 100 |
| 60 | (350 sq. cm.) 100 | (1,817 sq. cm.) 100 | (2,047 sq. cm.) 100 | (5,493 sq. cm.) 100 | 99 | [b] 99 |
| 50 | 98 | 98 | 96 | 93 | 90 | [c] 90 |
| 40 | 92 | 90 | 88 | 80 | 72 | 69 |
| 30 | 84 | 79 | 70 | 62 | 46 | 44 |
| 20 | 75 | 70 | 60 | 50 | 36 | 34 |
| 10 | 60 | 50 | 40 | 30 | 25 | 24 |

[a] After the leaves were measured on March 19, the first four leaves from each plant were harvested.
[b] On March 10, flower buds appeared.
[c] On March 19, flower buds appeared.

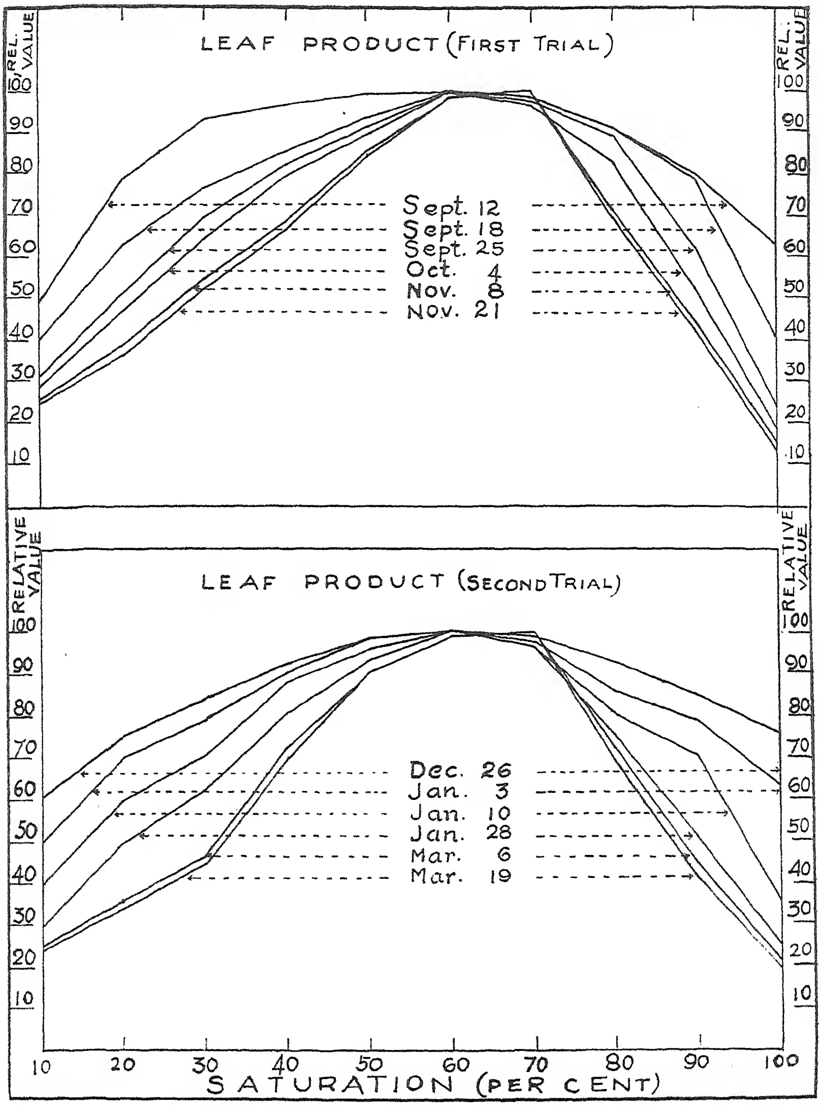


FIG. 2. Graphs showing effect upon the vigor of tobacco plants at different stages of growth development of varying the moisture content of sandy loam soil in pots.

of growth-curve of the plants is the same as the growth-curve observed on September 12. And, similar measurements obtained on September 25 and October 4 showed more markedly the effect of varying the moisture content of the soil upon the rate of growth of the tobacco plants. During this period the

plants in the 60 pèr cent saturation still maintained the lead in the rate of fast growth. Starting from the lowest to the highest per cent saturation the total growth of the plants on October 4 expressed relatively was: 29, 47, 64, 79, 89, 100, 97, 83, 52 and 18 (Fig. 2). It is to be noted that the plants in the 100 per cent saturation were now poorer than those in 10. The former had a relative value of 18 and the latter 29. It is apparent that an insufficient amount of aëration in the medium (100 per cent saturation) was more detrimental to the growth of the tobacco plant than a deficiency of soil-moisture as low as 10 per cent saturation. In fact, on November 21, the duplicate culture in the 100 per cent saturation died and the one living had its leaves chlorotic and the lower ones were dried. The poor condition of the plants in this saturation (100) is due to the lack of sufficient supply of oxygen. This contention is supported by Maximov who states:

> On too compact or submerged soils, . . . . plants developed poorly, or perish . . . . It is not the excess of water itself that is injurious to the plant, . . . . it is rather the lack of oxygen resulting from submersion that is harmful . . . . Lack of aëration may lead to other consequences having an indirect effect of the root system . . . . The various bacterial processes of the soil, for instance, may be replaced by anaerobic fermentation . . . . Poisonous products of anaerobic decay may accumulate in the soil . . . . All these substances poison the roots of plants and check water absorption.

In the light of Maxinov's explanation aëration especially for plants like tobacco should not be overlooked, nor arid soil should be preferred. For in medium with insufficient soil-moisture supply, the root hairs compete for water with the surrounding soil particles. The results of this study (Tables 3 and 4) show that beginning from 10 to 40 per cent saturations, inclusive, the plants under greenhouse conditions were always at a constant demand for more water as shown by the fact that the plants wilted during periods when conditions were favorable for rapid transpiration. The growths of these plants were also stunted. This interrupted rate of water absorption was detrimental to the normal development of the plants. In the words of Maximov he states:

> The greatest increase in volume of cell occurs . . . . only when water has an un-interrupted and unhindered access to the growing cells. With deficiency of water or an accumulation in the soil of substances inhibiting water supply the stage of elongation terminates too early and differentiation begins before the cells have reached their full size. The result will be a plant with smaller cells and shorter growth.

TABLE 3.—*Results of first trial showing average harvest data of tobacco plants grown in soil of various constant soil-moisture*

| Per cent saturation | Average total height | Average number of leaves per plant | Average measurement of 5 largest leaves from 1 plant | | | Average yield per plant (relative value) | Appearance of plant at priming period |
|---|---|---|---|---|---|---|---|
| | | | Length | Width | Breadth index | | |
| | *cm.* | | *cm.* | *cm.* | *cm.* | | |
| 100 | 37.5 | 8 | 16.8 | 9.0 | 54 | 13 | Plant, chlorotic (pale yellow green). Growth stunted. Old leaves, dried. Duplicate plant, dead. No flower. |
| 90 | 65.0 | 15 | 22.0 | 12.1 | 55 | 38 | Plant, pale-yellow-green. Growth stunted. One plant with mosaic symptom. No flower. |
| 80 | 112.3 | 28 | 28.1 | 15.1 | 54 | 64 | Plant, light-green. Growth fairly normal. One plant with mosaic symptom. No flower. |
| 70 | 159.0 | 30 | 32.3 | 17.8 | 55 | (31 gm.) 100 | Plant, well developed with long and broad light-green leaves. With flower. |
| 60 | 153.1 | 30 | 32.4 | 17.8 | 55 | 100 | Resembling plants in 70. With flower. |
| 50 | 133.1 | 28 | 30.0 | 16.2 | 54 | 83 | Plant, grass-green. Older leaves, dried at tips. Growth not vigorous. No flower. |
| 40 | 124.5 | 23 | 24.9 | 13.2 | 53 | 63 | Plant, grass-green. Young leaves wilt at middle of day. Growth, slow. No flower. |
| 30 | 105.0 | 18 | 24.9 | 13.4 | 54 | 54 | Plant, grass-green. Young and medium-aged leaves wilt at middle of day. Growth, stunted. No flower. |
| 20 | 71.8 | 15 | 22.9 | 12.3 | 54 | 45 | Plant, grass-green. Leaves wilt at middle of day. Growth, stunted. Older leaves, dried. No flower. |
| 10 | 55.5 | 10 | 19.0 | 10.2 | 54 | 24 | Plant, grass-green. Leaves wilt as early as 10 o'clock in the morning. Growth, stunted. Older leaves, dried. No flower. |

TABLE 4.—*Results of second trial showing average harvest data of tobacco plants grown in soil of various constant soil-moisture*

| Per cent saturation | Average total height | Average number of leaves per plant | Average measurement of 5 largest leaves from 1 plant: Length | Width | Breadth index | Average yield per plant (relative value) | Appearance of plant at priming period |
|---|---|---|---|---|---|---|---|
| | *cm.* | | *cm.* | *cm.* | *cm.* | | |
| 100 | 41.0 | 10 | 16.6 | 8.8 | 53 | 15 | Plant, chlorotic. Growth stunted. Older leaves dried. No flower. |
| 90 | 92.1 | 20 | 22.2 | 12.2 | 55 | 40 | Plant, pale yellow. Growth stunted. Older leaves, dried. No flower. |
| 80 | 150.0 | 28 | 26.9 | 14.5 | 54 | 69 | Plant, pale green. Growth stunted. No flower. |
| 70 | 160.0 | 31 | 32.1 | 17.0 | 53 | (32 gm.) 100 | Plant, vigorous. Leaves, green, long, and broad. With flower. |
| 60 | 158.2 | 30 | 31.6 | 17.4 | 55 | 98 | Plant, vigorous. Leaves, green, long, and broad. With flower. |
| 50 | 141.1 | 25 | 30.0 | 16.2 | 54 | 85 | Plant, vigorous. Leaves, green, long, and broad. With flower. |
| 40 | 122.0 | 25 | 25.3 | 13.4 | 53 | 65 | Plant, green. Young leaves wilt at middle of day. Growth slow. No flower. |
| 30 | 92.3 | 20 | 23.9 | 12.9 | 54 | 56 | Plant, green. Leaves wilt at middle of day. Growth, slow. No flower. |
| 20 | 70.1 | 16 | 22.5 | 12.4 | 55 | 42 | Plant, green. Growth, stunted. Leaves wilt as early as 10 a. m. until 4 00 p. m. |
| 10 | 62.0 | 12 | 17.8 | 9.4 | 53 | 27 | Plants, green Growth, stunted. Leaves small and wilt as early as 9.00 a. m. |

TABLE 5.—*Chemical content* [a] *and quality of crop obtained from plants grown in soil of various constant soil-moisture*

| Per cent saturation | Moisture | Ash: Wet | Ash: Dry | Nitrogen: Wet | Nitrogen: Dry | Nicotine: Wet | Nicotine: Dry | Duration of glow | Color of ash [b] |
|---|---|---|---|---|---|---|---|---|---|
| | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Second* | |
| 100 | 9.39 | 26.68 | 29.44 | 0.47 | 0.51 | (c) | (c) | 5.0 | Palid quaker drab. |
| 90 | 8.34 | 24.04 | 26.22 | 0.57 | 0.62 | (c) | (c) | 5.0 | Do |
| 80 | 8.50 | 26.67 | 29.14 | 0.11 | 0.12 | (c) | (c) | 5.2 | Do |
| 70 | 10.05 | 30.75 | 34.18 | 0.72 | 0.80 | (c) | (c) | 6.0 | Do |
| 60 | 9.01 | 28.27 | 31.06 | 1.16 | 1.27 | 0.84 | 0.92 | 4.8 | Gray (pale gull gray). |
| 50 | 10.95 | 28.50 | 32.00 | 0.98 | 1.30 | 2.07 | 2.32 | 2.6 | Palid mouse gray. |
| 40 | 10.98 | 28.72 | 32.26 | 1.24 | 1.39 | 1.24 | 1.39 | 3.0 | Do. |
| 30 | 13.45 | 32.15 | 34.14 | 1.13 | 1.20 | 2.22 | 2.35 | 2.8 | Do. |
| 20 | 11.13 | 28.47 | 32.03 | 1.38 | 1.55 | 1.82 | 2.04 | 2.4 | Do. |
| 10 | 12.23 | 27.97 | 31.86 | 1.19 | 1.35 | 2.26 | 2.57 | 2.5 | Pale mouse gray. |

[a] Analyzed by the Agricultural Chemistry Section, Bureau of Plant Industry.
[b] Color of ash was compared with Ridgway's Color Standards and Nomenclature.
[c] Nicotine not detected on the amount of sample used.

*Flowering.*—The results of two trials conducted under greenhouse conditions show that earliness of flowering was influenced by the amount of soil moisture present in the medium. This was evidenced by the fact that the tobacco plants grown in the 60 and 70 per cent saturations in the two separate trials flowered first and followed by those planted at 50 and 80. The plants at 10, 20, 30, 40, 90, and 100 per cent saturations did not flower up to the time when the last harvest was done (Tables 1 and 2).

*Number of leaves.*—The number of leaves developed from each plant shows direct correlation with the vigor of the plant. David (1925) found also positive correlation between total number of leaves and height of plants. Under greenhouse conditions the tallest and most vigorous plants were those planted in the 60 and 70 per cent saturation (Fig. 3) and each plant had an average number of thirty leaves. Those plants grown in the 10 and 100 per cent saturations had very poor growth and produced only about one-third as much leaves per plant (Table 3). It is very probable that some of the initiating cells for the formation of leaves that arise close to the apex of the stem failed to divide due to very poor growth caused by either insufficient water content in the medium or due to inadequate amount of soil air as was the case in the 100 per cent saturation. The lack of water supply in the 10 per cent saturation was shown by the fact that the leaves wilted almost daily about the middle of the day (Tables 3 and 4). This condition of the leaves was detrimental to the normal progress of photosynthesis and finally to the growth development of the plant. According to Sach and Nagamatsz (1888), cited by Palladin, no starch is formed by wilting leaves, a fact which Stahl (1894), also cited by Palladin, believed to be due to the stomatal closure that accompanies wilting. It is very apparent, therefore, that the poor growth of the plants in the 10 per cent saturation resulted in the production of only few leaves which was due principally to the aggregate effect of interrupted water absorption and photosynthesis.

*Size and shape of leaves.*—Although the tobacco plants were grown under varying amounts of soil-moisture, the shape or form of the leaves did not change. This is shown by the constancy of the ratio obtained by dividing the width of the leaf by its length and the quotient multiplied by 100 (Tables 3 and 4). This ratio is called "Breadth Index." Figure 2 shows

plainly that in the graph for breadth index of all the cultures when plotted against percentage saturations, a line which is almost "straight" is formed. Under greenhouse conditions, unlike the effect of varying amounts of water vapor in the atmosphere, the water content of the soil even if present in varying amounts in the medium did not modify the shape of the tobacco leaf. However, the size of the leaf blades was greatly changed depending of course upon the amount of water present in the soil. The poor plants were those grown in the 100, 90, 40, 30, 20, and 10 per cent saturations and all had small leaf blades. The most vigorous plants were those grown in the 60 and 70 per cent saturations and also had the biggest leaf blades (Tables 3 and 4). If we consider the 10, 20, 30, and 40 per cent saturations as dry soil and the 60 and 70 per cent saturations as moist soil, then the result of this experiment confirms the finding of Kohl on *Tropaeolum majus* (see Palladin, 1914) that when the plants were cultivated in moist and dry soil and the external condition of the air was dry (both cultures) the relative sizes of leaf blades were 4 for the former (moist) and 1 for the latter (dry).

*Average yield per plant.*—The effect of various constant soil-moisture upon the growth of tobacco plant is finally expressed by the total yield per plant. Table 3 shows that the heaviest yield of cured leaves was obtained from cultures grown in 60 or 70 per cent saturations. In the second trial observation (Table 4) the heaviest yield was obtained in the 70 per cent saturation. Those that were grown in the 60 per cent saturation were close second. Kiesselbach (1916) also obtained in the case of corn a maximum production of dry matter when the water content of the soil was at approximately 70 per cent saturation. Tobacco plants grown in wetter soil over 70 per cent saturation and drier soil less than 60 per cent had poor yields (Fig. 2). The poorest yield was obtained in the 100 per cent saturation and the next poorest was from the 10.

## EFFECT OF SOIL-MOISTURE UPON QUALITY AND CHEMICAL CONTENT OF TOBACCO LEAF

Cured leaves of tobacco plants grown in the 60 and 70 per cent saturations had light green color, pliable, and finely textured. Those plants in the 80, 90, and 100 per cent saturations had leaves that were yellowish-red, coarse, and not elastic. And

from the plants grown in 10, 20, 30, 40, and 50 per cent saturations the leaves after curing possessed dark-brown color, rough in texture, and non-pliable.

*Color of ash.*[a]—Tobacco leaves with white ash are preferred and the whiter the color of the ash the better is the leaf. The amount of soil-moisture in the medium affected the color of the ash. Leaves of plants grown in the 100, 90, 80, and 10 per cent saturations were pallid quaker drab (45 per cent white) and those in the 60 per cent saturation the color of the ash was pale dull gray (70 per cent white). The leaves of plants grown in the 50, 40, 30, and 20 per cent saturations had pallid mouse gray color of ash (45 per cent white) and the color of the ash from those in the driest medium, 10 per cent saturation, was pale mouse gray (22.5 per cent white).

*Burning quality.*—The glowing capacity of tobacco leaves depends principally upon two factors: first, the moisture content of the leaf and second, its total chemical composition. The effect of the first factor upon the burn is obvious and it is interesting to note that tobacco plants grown in the relatively dry soil with soil-moisture ranging from 10 to 50 per cent saturations had higher percentage of moisture content than plants grown in the wetter soil. Consequently, the former had poorer glowing capacity than that of the latter (Table 5).

*Chemical content.*—Table 5 shows that leaves of tobacco plants grown in the 100, 90, 80, and 70 per cent saturations contained less nitrogen (dry basis) than those in the relatively dry medium (10, 20, 30, 40, 50, and 60 per cent saturations). The first group had an average of 0.51 per cent nitrogen (dry basis) while in the latter the amount of nitrogen content averaged 1.34 per cent. This finding corroborates the results of Breaves and Carter (1923) who also observed a decrease in the nitrogen content of wheat, oats, and barley when the irrigation water used in their growth was increased. But whether the amount of nitrogen content of the leaf has an effect upon the glowing capacity of the leaf, this paper does not attempt to determine. However, the results gathered seem to indicate that leaves with poor glowing capacity have high percentage of nitrogen and those with hight glowing capacity have very low percentage. It appears, therefore, that if nitrogen is in excess, the quality of the leaf (glowing capacity) will likely suffer.

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[a] The color of ash was determined by using Ridgway's color standards and nomenclature.

Table 5 shows further, that the amount of nicotine present in the samples analyzed varied greatly depending upon the amount of soil-moisture present in the soil. Nicotine was not detected from the amount of samples used from plants grown in the 100, 90, 80, and 70 per cent saturations. Only 0.92 per cent of nicotine (dry basis) was noted from the samples of leaves grown in the 60 per cent saturation and those in the 10, 20, 30, 40, and 50 per cent saturations had nicotine ranging from 1.24 to 2.26 per cent. It is also very interesting to note that when the amount of nitrogen was high in the sample there was also noted a high amount of nicotine, and when the nitrogen content of the leaf was low there was also very low amount of nicotine. The burn, flavor, aroma, and other important qualities of tobacco according to Garner are in no sense proportional to the amount of nicotine present. But, whether nicotine is a direct synthetic substance or a decomposition product of protein, the writers do not know. However, it is noteworthy to learn that relatively dry soil (10 to 50 per cent saturations) favored the production of relatively high amount of nitrogen and nicotine in the tobacco leaf. In the wetter cultures (from 60 to 100 per cent saturations) there were less nicotine and nitrogen found in the leaf (Table 5).

## CONCLUSION AND RECOMMENDATION

Under greenhouse conditions, potted tobacco plants grew best when the range of soil moisture in sandy loam soil was between 60 and 70 per cent saturations. They did not only produce the heaviest yield but also the leaves raised had the best quality. Plants grown in the 10, 20, 30, 40, and 50 per cent saturations had leaves with very poor glowing capacity and the leaves also contained high nitrogen and nicotine content. In the 80, 90, and 100 per cent saturations, the amounts of nitrogen and nicotine contents of the leaf were low and the duration of glow was long, but the leaves were yellowish-red, coarse, and non-elastic.

Percentages of soil moisture lower than 60 and higher than 70 per cent saturations were found unfavorable to both, growth and yield of tobacco plants. For practical purposes if irrigation is practiced, this degree of saturation is judged in the case of sandy loam soil by taking a handful of the soil to be tested and gripe it loosely. Upon opening the hand the soil particles will hold together and also leave an impress on the palm.

Under these conditions the amount of water in the soil is approximately between 60 and 70 per cent saturation. The soil, therefore, for tobacco raising, particularly of the wrapper type, must be well drained and at the same time it must be of such quality as not to part with its moisture too easily in a period of dry weather.

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# ILLUSTRATIONS

TEXT FIGURES

# SOME NOTES ON MAKAPUNO COCONUT AND ITS INHERITANCE

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THREE PLATES AND ONE TEXT FIGURE

The inheritance of the makapuno character in coconuts offers an inviting field for study. Results of such study will not only interest the plant breeders but also give information of great practical value to the coconut growers who intend to raise makapuno nuts in a large scale. So far as the writer knows there is yet no published work regarding its inheritance.

This paper contains some results of field observations on the distribution and inheritance of makapuno coconuts, which began in 1929, together with some suggestions relative to the selection of the makapuno seed nuts and how the production of makapuno nuts might be increased. In order to augment the previous findings, it was necessary to undertake further observations to obtain more field data.

## THE MAKAPUNO COCONUTS

The *makapuno* is a special type of coconut, Plate 1 (*a*) in which the meat almost fills the cavity of the shell; hence, the name in Tagalog, "makapuno," meaning filled. Instead of a hard and crispy meat and milk found inside ordinary coconuts, Plate 1 (*b*) there are in the makapuno nuts an outer portion which is white and soft substance corresponding to the meat of ordinary nuts and, in the inner portion a viscuous liquid, somewhat transparent or pellucid. It has been noted that the quantity of this viscuous inner substance seems to vary inversely with the age of the nuts.

Gonzales [1] (1914) gave in part the analysis of the two types of nuts as shown in the table below. These data were calculated to water-free basis.

[1] Gonzales, B. M. The makapuno coconut. Phil. Agr. and Forester 3 (1914) pp. 31–32.

TABLE 1.—*Analysis of ordinary nuts and makapuno nuts*

| Composition | Ordinary nuts | | Makapuno nuts | |
|---|---|---|---|---|
| | Meat | Milk | Firm outer portion | Soft inner portion |
| Water | 63.62 | 95.13 | 71.59 | 90.66 |
| Protein | 9.09 | 7.09 | 11.76 | 10.69 |
| Oil | 68.63 | ([a]) | 41.67 | 18.89 |
| Ash | 2.11 | ([a]) | 1.81 | 3.74 |

[a] Undetermined.

The foregoing table shows that there is a considerable difference in the chemical composition of these two types of nuts; the makapuno is richer in protein content but poorer in oil.

In all outside appearances the makapuno bearing trees can not be distinguished from the ordinary coconut trees. However, at bearing age, they can be differentiated by the actual examination of the ripe nuts. A certain per cent of the nuts from the makapuno bearing trees are makapuno nuts. The makapuno nuts approach closely the size, shape and the color of the skin of the ordinary nuts either from the same bunch or from the same tree. As regards the makapuno nuts from different trees they vary in the color of the skin from green, red to almost yellow as the ordinary coconuts, and also in the size and shape of nuts, as well as in the amount of edible flesh in the nuts (Plate 3).

The makapuno nuts may be distinguished from the ordinary nuts by shaking and tapping the nuts when they are sufficiently mature. Usually, the makapuno nuts being filled, or almost so, do not produce any sound when shaken, though some of them may give the characteristic sound of a thick liquid within. By tapping, the makapuno nuts give also a characteristic "filled" sound, so that an adept in selection can pick them out by shaking and tapping with great precision.

## DISTRIBUTION OF MAKAPUNO BEARING COCONUT TREES

Most of the makapuno nuts are raised in Laguna Province particularly in the barrios of Santo Angel or Ilog, San Lorenzo or Saluyan, and San Antonio or Balanga, municipality of San Pablo. A good number are also produced in the barrios of Cabanbanan and Sabang, municipality of Pagsanjan. Some makapuno nuts may be found in Dolores and other municipalities in Tayabas Province. A small number of makapuno nuts are

being raised in the Provinces of Batangas, Cavite, Pangasinan, in the Visayas, and in Davao. However, this type of coconut is hardly known in nothern Luzon, in some of the Bicol regions, in Capiz, in Zamboanga, in Basilan Island, and in many other places.

Most of the present supply is consumed in the City of Manila where it is best esteemed in the form of sweets. It is also made into ice creams, candies, and many other preparations. The possibility of raising makapuno coconuts in a large scale is very great as it commands a high price in the market, from 15 to 20 times or more than that of the ordinary nuts.

### POLLINATION AND ITS RELATION TO NUT PRODUCTION

Before considering the inheritance of the makapuno character in coconuts it is essential to consider briefly the process of pollination in coconut. According to Mendiola [1] (1926) there are three forms of pollination in coconut. The first one is between male and female flowers of the same cluster or *interfloral* pollination; the second, between flowers of different clusters of one and the same tree or *intercluster* pollination; and the third, between flowers of different trees or cross-pollination.

In coconuts the pollination between flowers of the same cluster or interfloral pollination is possible only with relatively few female flowers of a few trees, which become ready for pollination a day or two before all the male flowers in the same cluster fall to the ground. This fact accounts for the natural falling off of the majority of the undeveloped female flowers at such times when the intercluster pollination and the cross-pollination do not take place.

During favorable weather the flower clusters appear in overlapping succession thereby making intercluster pollination possible, of course aided greatly by insect, by wind, and by gravity; cross-pollination due to insects is not at all excluded. Under these circumstances many of the female flowers are fertilized so that unless some conditions, unfavorable to the normal development of the fertilized female flowers set in, large number of ripe nuts are produced. According to some information gathered, large number of makapuno nuts are obtained when the ripe nuts are produced in abundance. Apparently, both the interfloral and intercluster pollinations do not affect the normal

[1] N. B. Mendiola. A manual of plant breeding for the tropics. Bureau of Printing, Manila (1926) pp. 1–365.

ratio between the makapuno and the ordinary nuts produced, as both are akin to self-pollination.

Cross-pollination is the rule at such times when intercluster pollination is not possible as during the dry season when the trees are undernourished. A makapuno bearing tree cross-pollinated with pollen from ordinary trees will produce only one phenotype of nuts, i. e., ordinary or normal nuts. Such cross-pollination, therefore, tends to reduce the production of makapuno nuts.

In some of the makapuno plantations some trees are known to produce some makapuno nuts every time their ripe nuts are harvested. The owners call them "sure makapuno trees" or "*segurado*." Upon examination of the distribution of the trees in the plantations it was invariably found out that these trees are surrounded by other makapuno bearing trees, indicating that if a makapuno bearing tree is cross-pollinated with the pollen from another makapuno bearing tree the normal proportion between the makapuno and the ordinary nuts may not be altered. Likewise, some of the isolated makapuno bearing trees free from any cross-pollination with pollen from ordinary coconut trees are found to produce some makapuno nuts more or less regularly.

## INHERITANCE OF THE MAKAPUNO CHARACTER

The importance of this type of coconut has long been recognized by some of the planters in the Provinces of Laguna and Tayabas. At present there are some plantations as old as 60 to 70 years in which some of the trees are bearing makapuno nuts. In some younger plantations, however, some of the makapuno bearing trees are purposely planted in groups. These trees were grown from seeds borne with makapuno nuts in the same clusters, thus indicating that some of the coconut planters had already realized the fact that the makapuno type is an inherited character.

## METHODS OF PROCEDURE

Two sets of field studies were conducted to determine the inheritance of the makapuno character in coconuts. The first one was by counting and determining the ratio between the ordinary nuts and the makapuno nuts produced by some of the known makapuno bearing trees. The second set consisted of determining the ratio between the ordinary trees and the makapuno

bearing trees in some of the established plantations consisting of trees grown from seeds raised from the makapuno bearing trees.

## RESULTS

The number and the relative proportions of the two kinds of nuts are given in Table 2. In this connection, there are two conditions that must be stated in order to appraise properly the data shown in the table. First, that the data were obtained from the uncontrolled setting of nuts, that is, no artificial self-pollination was done, and second, that for some obvious reasons only the data from trees producing some makapuno nuts at the time of harvesting were considered.

TABLE 2.—*Segregation of nuts into ordinary and makapuno nuts*

| Number of trees | Ordinary nuts | Makapuno nuts | Deviation 3:1 ratio | Probable error | Deviation probable error |
|---|---|---|---|---|---|
| 6 | 34 | 9 | 1.75 | ±1.92 | .9 |
| 9 | 48 | 12 | 3.00 | 2.26 | 1.3 |
| 24 | 174 | 35 | 17.25 | 4.22 | 4.1 |
| 3 | 50 | 12 | 3.50 | | 1.5 |

The observed segregation of trees in the two established plantations studied are given in Table 3. In this observation only those plantations with makapuno bearing trees already marked in order to identify them from their sister normal trees were studied.

TABLE 3.—*Segregation of trees into ordinary and makapuno bearing trees*

| Total number of trees | Ordinary trees | Makapuno bearing trees | Deviation 1:2 ratio | Probable error | Deviation probable error |
|---|---|---|---|---|---|
| 60 | 27 | 33 | 7 | ±2.46 | 2.8 |
| 153 | 46 | 107 | 5 | 3.63 | 1.4 |
| Total 213 | 73 | 140 | 2 | 4.64 | 0.4 |

## DISCUSSION OF RESULTS

Makapuno nuts are produced from makapuno bearing trees so frequently that any geneticist would suspect at once that the makapuno character might be inherited in a mono-Mendelian fashion. Theoretically, in this type of inheritance the ripe nuts would segregate into two phenotypes in the proportion of 3

normal or ordinary nuts to 1 makapuno nut. A study of the data presented in Table 2 evidently will show that the mono-Mendelian theory of inheritance of the makapuno character is more or less substantiated, for 3 out of 4 cases gave deviations almost equal to their respective probable errors, indicating relatively high probability that such deviations would occur due to random sampling.

Case No. 3, however, showed a large deviation of 17.25±4.22 nuts from the expected 3:1 proportion. This deviation is not very surprising as it has been stated above that all these data were obtained without artificial self-pollination and that there might have taken place in bloom cross-pollination with the pollen from the normal or ordinary coconut trees which tended to reduce the makapuno production. Another source of error may be mentioned in this particular case. Some of the doubtful makapuno nuts might have been classified with the normal nuts.

Let it be assumed that the makapuno type of coconut is a mono-Mendelian character, therefore, the genotypic segregation of nuts would be in proportion of 1 (MM) normal nut to 2 (Mm) hybrid nuts, otherwise normal nuts to 1 (mm) makapuno nuts following a monotypic ratio of 1:2:1, respectively (Plate 3). The first 2 biotypes are normal nuts as regards germinability but the first one will develop into a tree producing only normal nuts and each of the second biotype will grow into makapuno bearing tree. Theoretically, therefore, the mono-Mendelian 1:2 ratio of the normal and the makapuno bearing trees respectively, must be existing in the established makapuno plantations.

*Segregation of trees.*—Without reference to the field data presented in this report the author has obtained from a number of makapuno growers some information on the relative proportion between the ordinary trees and the makapuno bearing trees in their plantations. Their answers were interesting in that they seem to agree to the mono-Mendelian segregation. In fact one of the planters having a number of about 40 to 45 years old makapuno plantations consisting of no less than 3,000 trees has given the information that about 2,000 of his trees had actually produced some makapuno nuts.

In a plantation in barrio Putol, San Pablo, Laguna, containing 60 bearing trees of about 48 years old, there were 27 ordinary coconut trees and 33 makapuno bearing trees (see Table 3). According to the mono-Mendelian inheritance the expected proportion of the basis of 1:2 ratio is 20 ordinary to 40 makapuno

bearing trees, whereas the observed proportion was 27:33, thus, having a deviation of 7.00±2.46 trees or 2.8 times its own probable error showing a probability of 5.9 times in 100 trials that such a deviation may be expected to occur.

A counting made in another plantation (Fig. 1) of about 50 years old in barrio Ilog or Santo Angel of the same municipality, showed that there were 46 ordinary to 107 makapuno bearing trees with a deviation 5±3.63 trees from the expected 1:2 ratio. Here the deviation is 1.4 times its own probable error with a

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | O | O | M | M | M | M | O | M | M | O | O | O |
| | M | M | O | M | M | M | M | M | M | O | O | O | O |
| | M | d | M | M | M | M | O | M | M | M | M | M | M |
| | M | M | O | O | M | M | M | O | M | M | M | M | M |
| | M | M | O | O | M | M | M | M | M | M | M | O | M |
| | M | M | O | O | O | M | M | M | M | M | O | O | s |
| | M | M | M | O | O | d | M | M | O | O | M | M | M |
| | M | M | M | M | M | O | M | O | O | M | M | d | M |
| | M | M | M | M | M | O | O | M | M | M | M | M | M |
| M | M | O | O | M | M | M | M | M | M | M | O | M | d |
| M | M | M | O | M | M | O | M | M | M | M | O | O | d |
| O | O | O | M | M | M | M | O | M | M | M | O | M | O |

FIG. 1. Diagrammatic planting plan showing the distribution of the ordinary (O) and the Makapuno (M) bearing trees in the plantation of Don Miguel de la Rama, in barrio Santo Angel (Ilog), San Pablo, Laguna, (d) dead and (s) non-bearing tree.

probability of 34.5 in 100 trials. Considering the two cases together, the observed proportion of the ordinary to the makapuno bearing trees is 73:140 trees, respectively, whereas the expected proportion on the basis of 1:2 ratio is 71:142 with a deviation of 2.00±4.64 trees. Here the deviation is even smaller than the probable error.

Although the data on the segregation of nuts were obtained without artificial pollination, it is interesting to note that three

out of four cases are in close agreement with the 3:1 ratio of the mono-Mendelian type of inheritance. Furthermore, the 1:2 proportion between the normal trees and the makapuno bearing trees found in the established makapuno plantations proved further that the makapuno type is of mono-Mendelian character.

## SELECTION OF MAKAPUNO SEED NUTS

The planting of seedlings from makapuno bearing trees should be encouraged, not only because the makapuno nuts command a good price in the market, but also on the basis of a sound speculation on the possibility of establishing a more or less lucrative industry that might result from a large production of makapuno nuts.

It has been the common practice of the planters to select for makapuno seed the nut at the tip or *"pusod"* of each bunch having one or more makapuno nuts. Others contend that the nuts nearest the makapuno in the bunch should be selected for seed. The latter may be more reasonable than the former, as the nuts nearest the makapuno had the greatest chance to be fertilized by pollen from the same bunch of flowers if not from the same flowers which produced the pollen that impregnated the makapuno nuts. How these nuts taken from different portions of the same bunch will breed with respect to makapuno character cannot at present be said. It is very doubtful if the results of such experiment, if conducted, would compensate the trouble that would be involved. According to the present observation, all good sized and well developed nuts in the same bunch with makapuno and from a tree which is more or less a regular bearer of makapuno nuts, may be used for seeds; and two-thirds of the seeds so taken may be expected to develop into makapuno bearing trees.

It was stated that there are two genotypes of seed nuts coming from a makapuno bearing tree. These genotypes have been designated as type *MM* and type *Mm* which may be expected to occur in the proportion of 1:2, respectively.

Theoretically, a makapuno bearing tree being a mono-hybrid, produces two kinds of female flowers or ovaries: the *M* normal ovaries and *m* makapuno bearing ovaries, in 1:1 proportion. If these ovaries were fertilized by pollen from a normal coconut tree, only two combinations are formed, the *MM* normal nuts and *Mm* hybrid nuts in the proportion of 1:1 and this accounts for the fact that cross-pollination of the makapuno bear-

ing trees by the normal trees tends to reduce the production of makapuno nuts in the former.

It might be mentioned in this connection that a normal tree may also give rise to a makapuno bearing seedling when by chance one of its ovaries had been cross-pollinated by a makapuno bearing pollen *m* from a makapuno bearing tree.

In the selection of makapuno seed nuts the important points to consider are the regular bearing habit, the size of nuts or the quantity of edible portion in the nuts, and the seeds taken from the clusters with one or more makapuno nuts.

## INCREASING MAKAPUNO PRODUCTION

There are various ways that might be suggested to increase the production of makapuno coconuts. One way is to improve the condition of the trees by manuring or fertilization, thereby making it possible for the flower clusters to appear in overlapping succession so that the intercluster pollination can take place. Another which might be a less practical method is by artificial pollination with the pollen from trees that are also bearing makapuno nuts, preferably from sister trees.

The removal of the normal or non-makapuno bearing trees from the established plantations might result in an increase production of makapuno nuts, for by so doing the cross-pollination from such trees which tends to reduce makapuno production will be eliminated. This idea gives rise to a new system of planting which may be suggested to any prospective makapuno grower, that is, to plant the makapuno seed nuts in groups of 2 or 3 seeds per hill and distanced at 12 to 15 meters each way between groups. Later on, the normal trees which do not produce makapuno nuts, about one-third of the total number, may be removed without considerable loss in the production of the whole plantation.

Another though quite a remote possibility of increasing makapuno yields is to find some means to germinate the embryos found in the makapuno nuts. It is believed that these embryos are alive but unable to germinate under the ordinary method of germinating seed coconuts. Its failure to germinate is most probably due to lack of "milk" necessary to maintain the germination of the embryos as in the case of normal nuts. It was observed that even the normal nuts failed to germinate whenever the water in the nuts had been excessively reduced.

The problem of germinating the makapuno embryo is an important subject for physiological study in the laboratory which has been barely started. In all probability the makapuno type is a homozygous recessive character, so that the absence of cross-pollination with the other types will bear all makapuno nuts. Unless the makapuno embryos are inherently weak or incapable of germination or of continuous vegetative growth it is reasonable to expect that all efforts to germinate them in the laboratory will come out successful in the end.

## SUMMARY

The data presented in this paper indicate strongly that the makapuno character in coconuts is inherited in a mono-Mendelian fashion. Being recessive to its normal allelomorph the makapuno bearing trees are heterozygous for the makapuno character. The normal nut has been designated as *MM* type; the heterozygous or makapuno bearing coconuts as *Mm* type; and the makapuno nut as *mm* type.

In the light of the results obtained it becomes evident that there are two biotypes of trees coming from the makapuno bearing trees, the normal trees of the *MM* type and the makapuno bearing trees of the *Mm* type, which actually exist in the established makapuno plantations in the proportion of approximately 1:2, respectively.

The size of nuts, the quantity of the edible portion in the nuts, and the regular bearing habit are the points to be considered in the selection of makapuno seed nuts.

Increasing the makapuno production by manuring or fertilization, artificial pollination whenever practicable, and by the removal of all the non-makapuno bearing trees from the makapuno plantations are suggested. A new method of planting a makapuno plantation for the same purpose is also stated.

Mention is made of the presence of live embryos in the makapuno coconuts.

The most outstanding practical value of the results so far obtained from this study is the knowledge of the relative proportion between the normal trees and the makapuno bearing trees obtainable from the selected makapuno bearing mother trees. One may expect to get about 1,000 makapuno bearing trees from every 1,500 seedlings raised from seeds carefully selected from the makapuno bearing trees.

## RECOMMENDATIONS

The collection of more data on the production and segregation of the makapuno nuts, monthly or bi-monthly, for a number of years in order to study the fluctuation of makapuno production and to determine the factor or factors concerned is recommended. If facilities and funds permit it is suggested that the inheritance study should be carried on further with artificial pollination. Besides, more field information on the segregation of trees in the established plantations should be gathered.

The germination of the makapuno embryo in the laboratory should be pursued as well as the allied microscopic study of its morphology. On the belief that the makapuno embryo is alive and homozygous for makapuno character, efforts should be exerted to germinate it to find out the possibility of producing a plant that might produce all makapuno nuts.

# ILLUSTRATIONS

## PLATE 1

FIG. 1. Makapuno coconut showing the embryo.
2. Ordinary or normal coconut showing the embryo.

## PLATE 2

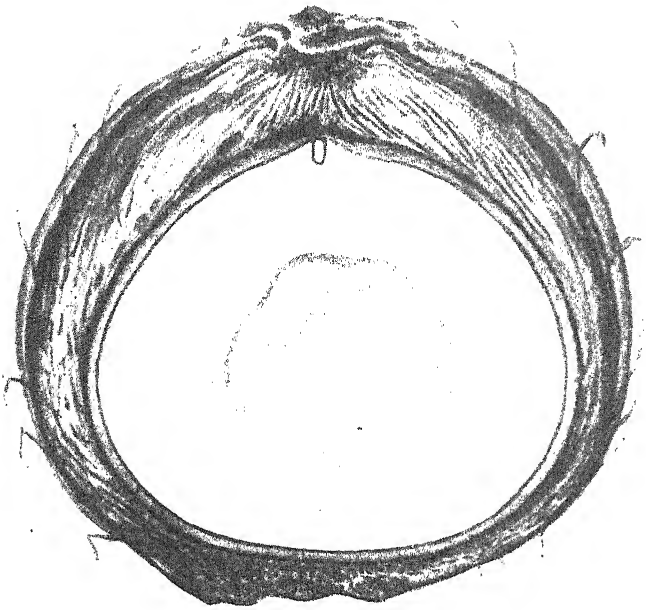
Different types of makapuno nuts.

## PLATE 3

Illustrative drawing showing the inheritance of makapuno type of coconut. 1, ordinary or normal nut; 2 and 3, the heterozygous or the makapuno bearing type; and 4, the makapuno type.

## TEXT FIGURE

FIG. 1. Diagrammatic planting plan showing the distribution of the ordinary (O) and the makapuno (M) bearing trees in the plantation of Don Miguel de la Rama, in barrio Santo Angel (Ilog), San Pablo, Laguna, (d) dead and (s) non-bearing tree.



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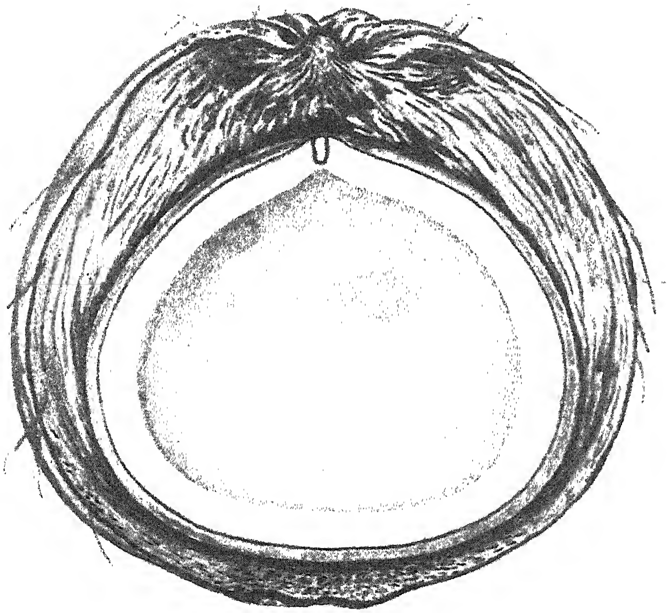


2

PLATE 1.

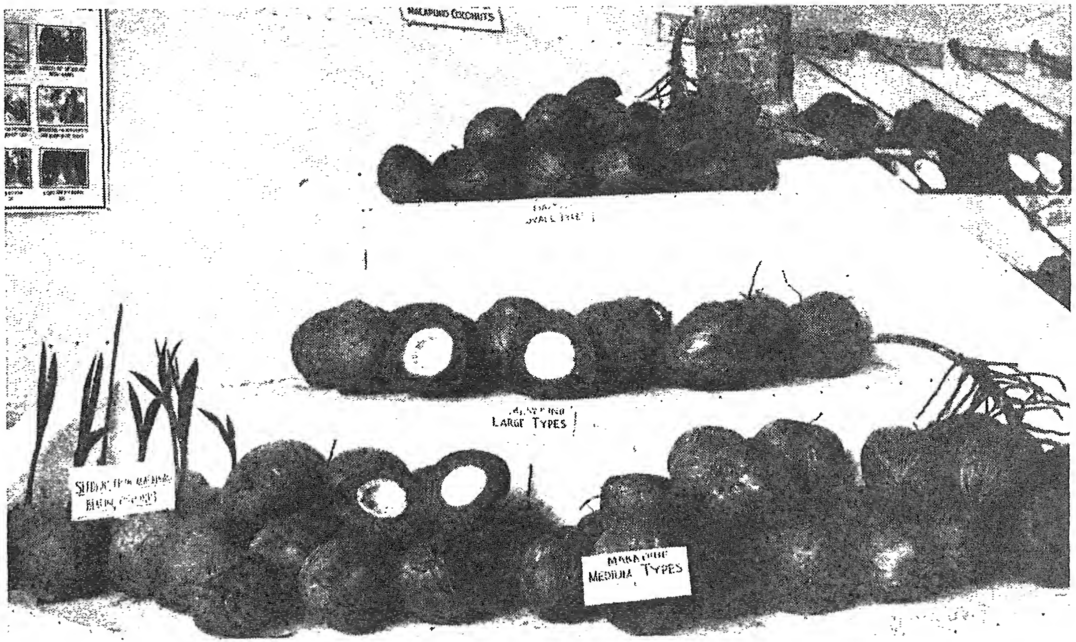
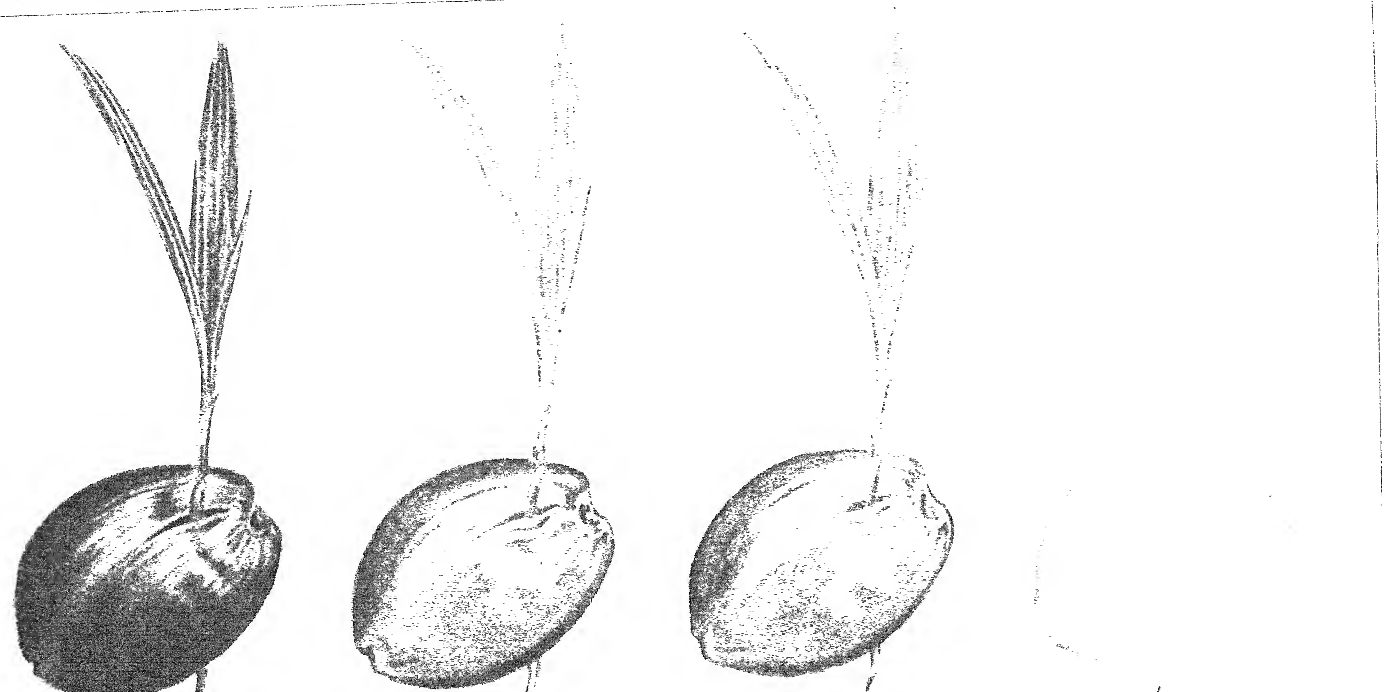



PLATE 2.



1 2 3 4

PLATE [illegible]

# LINE SELECTION OF KHAO BAI SRI

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## INTRODUCTION

The desire to improve plants is as old as agriculture. Desirable forms were preserved in the early days, and one of the outstanding examples of improved plant is the rice. Along this line it is recorded in the memoirs of the Manchu Emperor, K'hang-Hsi, that in 1662–1723 he did some selection work of a certain type of rice plant with fine grains.(1) This was propagated later on and became the source of his rice supply for 30 years.

The plasticity of the genus *Oryza* to which the cultivated rice belongs has given rise to the formation of thousands of varieties adapted under varied conditions.

## REVIEW OF LITERATURE

According to De Vries, Le Couteur assumed in the early part of the eighteenth century that selected plants beget similar offspring. Patrick Shireff, in the middle part of the century, corroborated the finding of Le Couteur, working on exceptional plants to produce new varieties.

Johannsen, in his experiment early in the twentieth century, concluded that improvement within a pure line is futile. This is corroborated by other investigators, working on other crops and characters. Parnal and others reported (1917) that the natural crossing in rice varied from 0.1 per cent in one variety and 2.9 per cent in another variety (2), (4), and (5).

During the last seventeen years of continuous culture, since its introduction from Siam into the Philippine Islands(3) the Khao Bai Sri variety of rice has manifested inconsistency both in heading and production. It is a quality rice which is rated as first class, extra superior both in the Philippines and abroad.

Be it stated in passing, that the over-production of rice in the rice producing countries during the last half decade has brought about quality discrimination and gives impetus to the production of a good quality rice that is in demand both in local and foreign markets.

The pedigree selection was made in Alabang Rice Station, Muntinlupa, Rizal, in 1930 to 1933 inclusive, and the strain or final test was conducted in Maligaya Rice Station in 1934.

## MATERIALS AND METHOD

In a propagation field planted to a mixed population of Khao Bai Sri nine desirable plants were observed and collected separately in 1929. In the following season (1930) the seeds from these plants were sown separately in seedbeds and were later transplanted in prepared paddies after six weeks. One hundred seedlings per row representing one elite were planted at a distance of 20 centimeters between hills. The different elites were planted in separate rows at a distance of 20 centimeters. Three check rows of the same variety consisting of mixed population were used. Two guard-rows were placed on both sides of the test plot and a check row was set between the fourth and the fifth rows of the elites to serve as basis for comparison. The whole test plot was, therefore, provided with border plants so as to exclude all possible border effects upon yields. In the successive years, however, the check rows were disregarded and only the elites were compared with each other, thus gradually eliminating them. The elites were numbered as 1247, which stands for P. I. number of the variety under study. P stands for plant and the suffixing figures stand for the number of the selected plant or elites in the order of planting in the row.

## RESULTS

The yields of the different rows of elites in the first year of planting are shown in Table I. Elites 1247–P1 yielding 1,156 grams per row and six best plants were selected; 1247–P2 yielded 1,232.0 grams and four best plants selected; 1247–P5 yielded 1,070 grams and five best plants selected; and 1247–P9 yielded 1,287.0 grams and three best plants were selected. These selected elites yielded much higher than the average yield of the checks and still higher than any of the other three elites tested.

TABLE I.—*Showing the performance of the elites in the first year planting, 1930*

| Elites | Yield of 100-plant row | Average yield of check rows |
|---|---|---|
| | *grams* | *grams* |
| Elite No. 1247–P1 | 1,156.0 | |
| Elite No. 1247–P2 | 1,232.0 | 974 |
| Elite No. 1247–P3 | 872.0 | |
| Elite No. 1247–P4 | 918.0 | |
| Elite No. 1247–P5 | 1,070.0 | |
| Elite No. 1247–P6 | 848.0 | |
| Elite No. 1247–P7 | 1,008.0 | |
| Elite No. 1247–P8 | 1,004.0 | |
| Elite No. 1247–P9 | 1,287.0 | |

The yields of the elites in the second year of selections are shown in Table II. Elites 1247–P1–1 with a yield of 1,583.3 grams to the row; 1247–P2–7 with a yield of 3,571.4 grams; and 1247–P9–1 with a yield of 1,786.7 grams were the highest yielders among the elites tested, and were then selected for planting in 1932 test.

TABLE II.—*Showing the yields of the elites in the second year tests, 1931*

| Elites | Yield per row 100 plants | Remarks |
|---|---|---|
| | *grams* | |
| Elite No. 1247-P1-1 | 1,583.3 | Selected for 1932. |
| Elite No. 1247-P1–2 | 1,326.5 | |
| Elite No. 1247–P1–4 | 1,395.8 | |
| Elite No. 1247–P1-6 | 1,322.9 | |
| Elite No. 1247–P1–7 | 1,340.0 | |
| Elite No. 1247–P1–10 | 1,656.2 | |
| Elite No. 1247–P2–7 | 3,571.4 | Selected for 1932. |
| Elite No. 1247–P2–8 | 1,410.0 | |
| Elite No. 1247–P2–9 | 1,448.5 | |
| Elite No. 1247–P2–10 | 1,418.3 | |
| Elite No. 1247–P5–1 | 1,418.3 | |
| Elite No. 1247–P5–2 | 1,367.3 | |
| Elite No. 1247–P5-6 | 1,450.0 | |
| Elite No. 1247–P5–7 | 1,510.4 | |
| Elite No. 1247–P5–10 | 1,469.3 | |
| Elite No. 1247–P9–1 | 1,796.7 | Selected for 1932. |
| Elite No. 1247–P9–3 | 1,500.0 | |
| Elite No. 1247–P9–10 | 1,357.1 | |

The materials of all the elites planted were harvested, dried, bundled separately and stored in the laboratory in 1932. Due

to lack of necessary helps the gathering of laboratory data was delayed and unfortunately the materials were badly damaged by rats. Thus the data secured could not be presented.

And because seeds and labor were limited and the planting season was already far advanced, only the seeds of the best elites were planted in the dapog seedbed and transplanted at the age of 12 days to catch up the loss of time. Of course, the treatment of sowing the seeds in the seedbed was different from the previous years, but the results of the 1933 crops helped in determining the best elites for strain test. The 1933 results are shown on Table III.

In Table III, the yields of the four best and high yielding elites are summarized.

TABLE III.—*Yield in grams of 100-plant rows of the different elites in 1930, 1931 and 1933*

| Elites | Years tested | | | | Average for 3 years |
|---|---|---|---|---|---|
| | 1930 | 1931 | 1932 | 1933 | |
| | *Grams* | *Grams* | *Grams* | *Grams* | *Grams* |
| Elite No. 1247-P2-7-1 | 1,232.0 | 3,571.4 | ---------- | 4,003.0 | 2,935.5 |
| Elite No. 1247-P1-1-1 | 1,156.0 | 1,583.3 | ---------- | 2,543.3 | 1,760.9 |
| Elite No. 1247-P1-10-6 | 1,156.0 | 1,656.2 | ---------- | 1,954.5 | 1,588.9 |
| Elite No. 1247-P9-1-1 | 1,287.0 | 1,786.7 | ---------- | 1,592.7 | 1,555.3 |

The elites No. 1247–P2–7–1, 1247–P1–1–1, and 1247–P9–1–1 were included in the final test and compared with the original variety P. I. No. 1247 Khao Bai Sri, and the elite No. 1247–P9–1–1 has been eliminated from the strain or final test on account of its low average yield.

## RESULTS OF FINAL TEST

Ten replications were made for each elite with an area of 1/40 acre or 1/200 hectare or 50 square meters each plot. The entire field may be described as irrigated plain or level and clay loam type with almost uniform soil condition.

All the seeds of selected elites including the seeds of the mixed population for checks were soaked on June 11, 1934, sown on June 13, 1934, and transplanted on July 30 to 31, 1934. Uniform treatments as to watering and weeding were given to all the plots. The results of the test are shown in Tables V and VI.

Elite No. 1247–P2–7–1 yielded 69.5±1.5 or 9.0±1.2 cavans per hectare more than the check; Elite No. 1247–P1–10–6 yielded 69.2±2.2 or 8.7±1.6 cavans over the check; and Elite No. 1247–P1–1–1 yielded 62.6±2.2 or 2.1±1.6 cavans higher than the check, whose difference in favor of the elite is quite insignificant.

TABLE V.—*Showing the yields of different strains of Khao Bai Sri, 1934–1935*

| Strain number and plot designation | Actual yield of plot of 50 sq. m. (kilos) | Computed yield per hectare | |
|---|---|---|---|
| | | Kilos | Cavans |
| 1247-P2-7-1-A- 1 | 14.0 | 2,800.0 | 64.2 |
| A- 2 | 14.0 | 2,800.0 | 64.2 |
| A- 3 | 13.5 | 2,700.0 | 61.9 |
| A- 4 | 14.5 | 2,900.0 | 66.5 |
| A- 5 | 16.0 | 3,200.0 | 73.4 |
| A- 6 | 14.0 | 2,800.0 | 64.2 |
| A- 7 | 16.0 | 3,200.0 | 73.4 |
| A- 8 | 18.5 | 3,700.0 | 84.8 |
| A- 9 | 16.0 | 3,200.0 | 73.4 |
| A-10 | 15.0 | 3,000.0 | 68.8 |

Mean: 69.5±1.5 cavans

| | | | |
|---|---|---|---|
| 1247-P1-1-1-B- 1 | 13.0 | 2,600.0 | 59.7 |
| B- 2 | 10.5 | 2,100.0 | 48.2 |
| B- 3 | 11.0 | 2,200.0 | 50.4 |
| B- 4 | 15.5 | 3,100.0 | 71.1 |
| B- 5 | 11.0 | 2,200.0 | 50.4 |
| B- 6 | 13.0 | 2,600.0 | 59.7 |
| B- 7 | 16.0 | 3,200.0 | 73.4 |
| B- 8 | 15.5 | 3,100.0 | 71.1 |
| B- 9 | 16.0 | 3,200.0 | 73.4 |
| B-10 | 15.0 | 3,000.0 | 68.8 |

Mean: 62.6±2.2 cavans

TABLE V.—*Showing the yields of different strains of Khao Bai Sri, 1934–1935*—Continued.

| Strain number and plot designation | Actual yield (kilos) per plot, 50 sq. m. | Computed yield per hectare | |
|---|---|---|---|
| | | Kilos | Cavans |
| 1247-P1-10-6-C- 1 | 14.0 | 2,800.0 | 64.2 |
| C- 2 | 12.0 | 2,400.0 | 55.0 |
| C- 3 | 17.0 | 3,400.0 | 77.9 |
| C- 4 | 13.0 | 2,600.0 | 59.6 |
| C- 5 | 12.5 | 2,500.0 | 57.3 |
| C- 6 | 16.0 | 3,200.0 | 73.4 |
| C- 7 | 18.5 | 3,700.0 | 84.8 |
| C- 8 | 15.0 | 3,000.0 | 68.8 |
| C- 9 | 15.0 | 3,000.0 | 68.8 |
| C-10 | 18.0 | 3,600.0 | 82.6 |

Mean: 69.2±2.2 cavans

| | | | |
|---|---|---|---|
| Check-D- 1 | 11.0 | 2,200.0 | 50.4 |
| D- 2 | 14.0 | 2,800.0 | 64.2 |
| D- 3 | 14.0 | 2,800.0 | 64.2 |
| D- 4 | 13.0 | 2,600.0 | 59.6 |
| D- 5 | 13.0 | 2,600.0 | 59.6 |
| D- 6 | 14.0 | 2,800.0 | 64.2 |
| D- 7 | 14.0 | 2,800.0 | 64.2 |
| D- 8 | 13.0 | 2,600.0 | 59.6 |
| D- 9 | 14.0 | 2,800.0 | 64.2 |
| D-10 | 12.0 | 2,400.0 | 55.0 |

Mean: 60.5±1.0 cavans

TABLE VI.—*Showing summary of Table V*

| Strain | Mean yield per hectare | Difference in increase over check | Remarks |
|---|---|---|---|
| | *Cavans* | *Cavans* | |
| Check: | 60.5±1.0 | | |
| 1247-P2-7 -1 | 69.5±1.5 | +9.0±1.2 | Significant. |
| 1247-P1- 1-1 | 62.6±2.2 | +2.1±1.6 | Not significant. |
| 1247-P1-10-6 | 69.2±1.0 | +8.7±1.6 | Significant. |

## CONCLUSIONS

Strain No. 1247–P2–7–1 from the initial selection to the completion of the test has shown consistently high yields. It yielded more than any of the other elites, and has given a significant difference of 9.0±1.2 cavans over the check in the final test. Strain No. 1247–P1–10–6 has shown similar productivity although slightly lower than the former strain. Strain 1247–

P1–1–1 yielded 2.1±1.6 cavans over the check, which increase is not significant.

## RECOMMENDATIONS

1. Strains No. 1247–P2–7–1 and 1247–P1–10–4 may be used for commercial planting.

2. For best results, these strains should be planted only on areas that can be drained, and have medium to fairly good soil with irrigation facilities.

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# UTILIZATION OF OUR IMPROVED NATIVE VARIETIES TO UTMOST ADVANTAGE FOR PROFITABLE TOBACCO PRODUCTION

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FIVE PLATES

The keen interest among our farmers in Central Luzon and in several provinces in the Visayan Islands in raising tobacco as one of their major crops is a sure sign that sooner or later tobacco growing will no longer be confined in the Cagayan Valley. It is important, therefore, that the farmers in these new tobacco regions be guided accordingly at the start to avoid or at least minimize failures and disappointments. A system of growing tobacco of the cigar and batek types with a better chance of earning a more decent profit than with the prevailing system of growing these types, is briefly described in this paper. Customarily, our tobacco farmers produce either a pure "liso" (cigar filler) or pure batek crop from their plantations and in a few instances a combination of batek and liso tobacco. This paper touches a new phase in tobacco production. It advocates producing more than one kind of tobacco crop from one plantation. This is made possible through the improvements made on two native varieties of tobacco which are now very appropriate for double and triple purposes. These two varieties are:

1. *Simmaba.*—This is a tall variety with a large stalk and medium-closed internodes. It reaches a height of from 200 to 250 centimeters and develops as many as from 18 to 36 leaves. The leaves are big, deep green when fresh, the width more than half the length, smooth, nearly erect, and from elliptical to nearly ovate in shape. The veins are medium-fine and approach an almost right angle position. The petiole is broadly winged. The standard leaves have an average measurement of from 78 to 104 centimeters in length and 46 to 68 centimeters in width. This variety is quite resistant to the wilt disease and can thrive under somewhat droughty conditions as in Ilocos. It is the best variety for wrapper purposes in shade culture.

This variety was discovered by the senior author about six years ago in the interior districts of La Union, grown by the highlanders in the mountainous district of the province. It was brought to the lowland and with the help of coöperators it was improved by selection for three seasons. The original growers themselves do not know how this type of tobacco came into their possession. According to Paguirigan, this variety is similar if not the same as the Marogui variety of the Cagayan Valley. Gutierrez advanced the opinion that the Simmaba must be a natural cross between the native variety which farmers in La Union call San Juan and the acclimatized Sumatra varieties. If the dominant external characteristics of the so-called San Juan and the Philippine Sumatra varieties are studied, one will find them present in the Simmaba. The Simmaba bears the shape, angle of venation and erect leaf position of the Sumatra when the leaves are not yet over-matured, and the size, deep green color of the leaves, and the late maturing habit of the San Juan variety. The characteristics of the Simmaba are well-pronounced when grown in La Union. Gutierrez' contention of the probable origin of this variety gains ground when one remembers that way back in 1918 to 1922, the Naguilian Tobacco Station of the old Bureau of Agriculture was growing and distributing various kinds of tobacco seeds including the Sumatra. Undoubtedly, the farmers may have grown the Sumatra side by side with their native tobacco. Natural cross-pollination under this condition was, therefore, possible. The farmers, not in the habit of bagging their mother plants naturally had in their stocks of seeds hybrids which, in the course of so many years of seasonal planting, have approached a high degree of purity. This variety upon being brought to the lowland was christened Simmaba because of its big-sized leaves.

2. *Vizcaya.*—This variety is a native of the Cagayan Valley and was improved and standardized by the Ilagan Tobacco Experiment Station in Ilagan, Isabela. It also grows very tall with large stalk but with longer internodes than the Simmaba. It reaches a height of from 220 to 250 centimeters and develops as many as from 22 to 38 leaves. The leaves are also big, light green in color, but the width is less than one-half the length. The leaf position is from horizontal to slanting, the petiole medium-winged, and the veins medium fine. The chief quality of this variety is its readiness to become light colored upon curing which gives it the desired color for wrapper. This variety is

preferable for shade culture under somewhat moist condition as in Laguna and Batangas.

PLANTING CIGAR FILLER TOBACCO FOR DUAL PURPOSES

When these two varieties described above are planted primarily for the production of cigar filler tobacco, the planting distances are set 70 centimeters between the plants in the row and 80 centimeters between the rows, or about 17,000 plants to the hectare. These planting distances enable the leaves particularly the standards to overlap intimately, thus naturally shading the sand leaves below. These sand leaves, because of their medium size are naturally thin, small-veined and fine in texture. The shade given them by the standard leaves above augments these qualities. Under prevailing practices these leaves are mostly allowed to deteriorate in the field or are destroyed during cultivation. Only in a few instances are they harvested together with the rest of the crop and when this is done they are already over-ripe, broken and soiled with earth. The buyers generally call these crop "terrozos" (soiled crop). If these sand leaves are picked at the proper time, poled and cured as wrapper leaves, they become the most valued portion of the entire production and certainly increase the income of the farmers without the necessity of increasing the expenses in production. These, should be picked before they reach complete maturity; poled face-to-face and back-to-back; and cured in a well ventilated curing shed. At least from four to six of the middle and lower sand leaves should be harvested, and from them three to six quintals of wrapper could be produced from a hectare of cigar filler plantation.

A hectare of cigar filler plantation under excellent conditions yields from twenty-five to thirty quintals of cigar filler if the sand leaves are also harvested as filler leaf. This gives an average of about 25 quintals to the hectare. At an average price of ₱10 a quintal of filler the gross income for every hectare is around ₱250. The average cost of production per hectare of cigar filler tobacco in the Philippines is around ₱230, giving the farmer a net profit of only ₱20 to the hectare.

Actual results now obtaining in the Tubao Valley, La Union, within the last six years clearly show that from a hectare of cigar filler tobacco plantation, at least 21 quintals of cigar filler and 4 quintals of medium fine wrapper, if the sand leaves are given care and picked and cured as wrapper crop, can be ob-

tained. These wrapper crops are usually sold locally at an average price of ₱25 a quintal. The buyers are mostly Chinese leaf tobacco dealers. It is very evident, therefore, that by converting the sand leaves as wrapper crop, the farmers can realize a gross income of about ₱310 to the hectare or a net profit of about ₱80 from a hectare of their cigar filler plantations which give them only ₱20 when only cigar filler crop is produced. It should be mentioned in this connection that the price of ₱25 a quintal of these wrappers derived from sand leaves is very low. If brought to the Manila market it will undoubtedly command a much better price. However, the quality of these sand leaves as wrapper and, consequently, their market value depend much upon the care given them. What is very important to remember is that they should be picked quite green and cured and graded accordingly.

### PLANTING BATEK LEAF TOBACCO FOR TRIPLE PURPOSES

These two varieties when grown principally for batek leaf tobacco production are set in the field at one meter apart between the rows and 80 centimeters between the plants in the row. This is giving sufficient space for the expansion of the leaves and ample feeding area for the roots.

Originally, the batek tobacco industry was a monopoly of La Union and Northern Pangasinan while Ilocos Norte produced most of what was consumed locally. During the last two years, however, other provinces like Nueva Ecija, Laguna, and Batangas ventured in the production of this type of tobacco with fair results. The present practice of growing batek consists in producing it from the standard leaves only. Sometimes a little crop of cigar filler is obtained from the sucker leaves but in most cases none at all. The sand leaves are allowed to decay in the field or, when harvested, are classified as "terrozos." To get the full benefit and reward of their labor the farmers should get three kinds of tobacco crop from their batek plantations, viz:

First, wrapper crop should be obtained from the sand leaves which are only being destroyed in the field or are harvested as inferior grades of cigar filler. This is easily done by harvesting them at the proper state of maturity and curing them at a finger distance in a well-ventilated curing barn.

Second, when all the sand leaves are harvested, the plants are topped allowing only eight to ten standard leaves to remain for the production of batek. Topping in this case is not like pinch-

ing the buds as it is done in topping cigar filler tobacco. Topping should be done early and when the plants are most vigorous in growth and long before the flowering season sets in. Whatever leaves remain are allowed to mature and are only harvested when those famous yellowish brown spots called batek become well pronounced. At this maturing stage suckers are not allowed to develop.

Third, after all the batek leaves are harvested, two to four suckers are encouraged to grow for the production of cigar filler tobacco. These suckers or branches are again topped to encourage their development. The original plants having been topped early enough will naturally grow big branches with well-sized leaves which are still very ideal for cigar filler purposes.

From a hectare of good batek tobacco plantation an average of 4 quintals of wrapper, 20 quintals of batek and 8 quintals of cigar filler leaf tobacco can easily be harvested. At an average price of ₱25, ₱20 and ₱9 a quintal of wrapper, batek and cigar filler crops respectively, a hectare of good batek tobacco can give a gross income of ₱572 or a net profit of about ₱349.50, if the cost of production per hectare is ₱222.50. If only batek is produced the net profit is ₱177.50, or ₱172 more profit in favor of the triple purposes. If batek and cigar filler are produced the net profit is around ₱249.50, or ₱100 less gain where the three crops are produced.

## PRODUCING PURE WRAPPER CROP BY SHADING

The production of pure wrapper crop from these two varieties is effected by the use of artificial shade. Palm leaves, talahib grass, and abacá cloth are among the cheapest and most common materials now being used by wrapper growers. The production of this highly specialized product requires bigger outlay of capital and a great deal of technical knowledge which can only be acquired by experience. The average cost of production under Philippine conditions ranges from ₱600 to over ₱1,000 depending much upon the locality. At the present average prices of shade-grown wrapper, ranging from ₱4 to ₱2 a kilo, and the yield ranging from 12 to 16 quintals to the hectare, the gross income is big amounting to from ₱1,800 to ₱2,400 per hectare. The net income, however, will depend upon the cost of production which is variable. With the exception of a group of independent small farmers in La Union and Isabela, practically all the wrapper growers at the present time are confined to the big

landowners and capitalists. Present experiences show that even with the sufficiency of capital, it is hardly possible for even the big producers to start bigger production, due to the scarcity of trained specialists along this line. The rapid development of this new industry will depend mostly upon the ability of the young managers engaged by the big growers to equip themselves with the necessary technical skill through experience.

## GENERAL REMARKS

The successful production of wrapper leaf tobacco subsidiary to the main or principal crop of either cigar filler or batek is not only a possibility but has long been a reality. In the Cagayan Valley and in La Union Province wrapper tobacco of fair quality has for a long time been produced by the farmers from the sand leaves of their cigar filler or batek tobacco plantations. This is done in spite of the little attention given to the crops, specially with regard to the degree of maturity of the leaves when harvested and the curing method employed. These crops are sold to the buying firms not as wrapper but as filler tobacco. Once bought the buying firms reclassify the leaves, grade them accordingly and are sold to the tobacco factories as cigar wrapper. The writers are aware of two prominent tobacco dealers in Manila who are selling this type of wrapper tobacco at prices ranging from ₱70 to ₱100 a quintal of 46 kilos. The biggest factories in Manila with big haciendas in the Cagayan Valley are utilizing a big volume of wrapper derived from the sand leaves of their cigar filler tobacco plantations in that region.

There are numerous other native tobacco varieties being grown in many parts of the Philippines. Undoubtedly, these have some qualities that are desirable. Most, however, are deficient in quality for wrapper purposes. The improved varieties, Simmaba and Vizcaya, besides possessing the excellent qualities for cigar filler and batek tobacco, are also the most ideal for the production of wrapper either in shade culture or in open culture.

Having the right soil and climatic conditions coupled with a more progressive method of culture and curing processes, the tobacco farmers, particularly the small producers, can increase their income without the necessity of increasing their cost of production by growing these two improved varieties for double or tripple purposes. Here lies one of the secrets of raising tobacco with profit-producing of two or three kinds of crop from one plantation.

For a more detailed information regarding the culture of cigar filler, cigar wrapper, and batek leaf tobacco, the readers are referred to the Farmers' Circular Nos. 15, 17, and 18 of the Bureau of Plant Industry. These circulars are distributed free of charge upon request.

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TABLE 1.—*Cost of producing one hectare of cigar filler with cigar wrapper leaf tobacco as secondary crop*

1. Preparation and sowing of seedbeds............ September and October
2. Transplanting season.......................................... November and December
3. Harvesting season............................................... February, March, Apr. May
4. Distances of planting........................................ 80 cms. × 70 cms.
5. Number of plants to the hectare.................... 17,750
6. Estimated yield per hectare............................ 1,250 kilos or 25 quintale

| | Man | Woman | Animal | Approximate cost |
|---|---|---|---|---|
| | *Days* | *Days* | *Days* | *Pesos* |
| 1. Curing barn of light materials worth ₱150.00 (6 m. x 12 m. x 3 m.) to last for three years | -------- | -------- | -------- | 50.00 |
| 2. 1,000 palillos | -------- | -------- | -------- | 10.80 |
| 3. 200 grams of seeds | -------- | -------- | -------- | 1.00 |
| 4. Preparation and sowing of seedbeds 20 beds each of 1 m. x 10 m. | 8 | -------- | 8 | 8.00 |
| 5. Rearing of seedlings up to transplanting time | 5 | 10 | -------- | 7.00 |
| 6. Preparation of field three plowing and 3 harrowing | 12 | -------- | 12 | 14.00 |
| 7. Transplanting | 10 | 30 | -------- | 17.00 |
| 8. Three times cultivation | 8 | -------- | 8 | 9.00 |
| 9. Worming, topping and suckering | -------- | 40 | -------- | 12.00 |
| 10. Harvesting | 5 | 60 | -------- | 22.00 |
| 11. Poling and sticking | 10 | 80 | -------- | 32.00 |
| 12. Barn operation | -------- | 10 | -------- | 7.00 |
| 13. Fermentation | 4 | 10 | -------- | 6.00 |
| 14. Bundling and classification | -------- | 80 | -------- | 24.00 |
| 15. Incidentals | -------- | -------- | -------- | 10.00 |
| Total expenses | -------- | -------- | -------- | 229.80 |

| | |
|---|---|
| Approximate yield per hectare if cigar filler is only produced, 1,250 kilos or 25 quintales at ₱10 a quintal | 250.00 |
| Total expenditure | 229.80 |
| Net gain | 20.20 |
| Approximate yield per hectare if cigar filler and wrapper crops are produced— | |
| (*a*) 4 quintales of wrapper at ₱25 each | 100.00 |
| (*b*) 21 quintales of cigar filler at ₱10 each | 210.00 |
| Gross income | 310.00 |
| Total expenditure | 229.80 |
| Net gain | 80.20 |

TABLE 2.—*Cost of producing one hectare of batek leaf tobacco with cigar filler and cigar wrapper as secondary crops*

1. Preparation and sowing of seeds................ September and October
2. Transplanting season........................................ November and December
3. Harvesting season ........................................ March, April, and May
4. Distances of planting........................................ 1 m. × 80 centimeters
5. Number of plants to the hectare.................. 12,500 plants
6. Estimated yield per hectare.............................. 20 quintales batek

| Items of operation | Man | Women | Animal | Approximate cost |
|---|---|---|---|---|
| | *Days* | *Days* | *Days* | *Pesos* |
| 1. Curing barn of light materials worth ₱150.00 (6 m. x 12 m. x 3 m.) to last for three years | -------- | -------- | -------- | 50.00 |
| 2. 1,000 palilos | -------- | -------- | -------- | 10.00 |
| 3. 200 grams of seeds | -------- | -------- | -------- | 1.00 |
| 4. Preparation and sowing of 18 seedbeds each of 10 sq. m. area | 7 | -------- | 7 | 7.00 |
| 5. Rearing of seedlings to transplanting | 4 | 8 | -------- | 6.00 |
| 6. Preparation of field 3 plowing and 3 harrowing | 12 | -------- | 12 | 14.00 |
| 7. Transplanting | 8 | 28 | -------- | 13.20 |
| 8. Three times cultivation | 8 | -------- | 8 | 9.60 |
| 9. Worming, topping, suckering | -------- | 35 | -------- | 10.50 |
| 10. Harvesting | 5 | 60 | -------- | 22.00 |
| 11. Poling and sticking | 10 | 80 | -------- | 32.00 |
| 12. Barn operation | -------- | 10 | -------- | 7.00 |
| 13. Fermentation | 4 | 10 | -------- | 6.20 |
| 14. Bundling and classification | -------- | 80 | -------- | 24.00 |
| 15. Incidentals | -------- | -------- | -------- | 10.00 |

| | | |
|---|---|---|
| Total expenses | ₱222.50 | |
| Estimated yield, 20 quintales batek at ₱20 a quintal | | ₱400.00 |
| Net profit if only batek is produced | 177.50 | |
| Additional yield, 8 quintales of cigar filler at ₱9 a quintal | 72.00 | |
| Net profit if sucker leaves are harvested as filler | 249.50 | |
| Additional yield of 4 quintales wrapper at ₱25 a quintal | 100.00 | |
| Net profit if in addition the sand leaves are harvested and cured as wrapper leaf tobacco | 349.50 | |

TABLE 3.—*Cost of producing one hectare of shade-grown wrapper leaf tobacco*

| | |
|---|---|
| 1. Preparation and sowing of seedbeds | September and October |
| 2. Transplanting season | November and December |
| 3. Shading period | January and February |
| 4. Harvesting season | February to May |
| 5. Planting distances | 80 cms. × 70 cms. |
| 6. Number of plants to the hectare | 17,750 |
| 7. Estimated yield per hectare | 750 kilos. |

| Items of operations | Approximate cost |
|---|---|
| | *Pesos* |
| 1. Seedbed and rearing of seedlings | 8.00 |
| 2. Preparation of field | 25.00 |
| 3. Transplanting | 16.00 |
| 4. Cost of shading materials | 200.00 |
| 5. Erecting shed tent | 40.00 |
| 6. Worming | 20.00 |
| 7. Cultivation | 15.00 |
| 8. Priming and poling | 80.00 |
| 9. Curing and fermentation | 15.00 |
| 10. Classification and bundling | 100.00 |
| 11. Baling and baling materials | 25.00 |
| 12. Depreciation of curing barn | 60.00 |
| 13. Miscellaneous expenses | 100.00 |
| Total expenditure per hectare | 704.00 |

Approximate yield per hectare:

| | |
|---|---|
| 200 kilos at ₱3 a kilo | ₱600.00 |
| 200 kilos at ₱2 a kilo | 400.00 |
| 100 kilos at ₱1.50 a kilo | 150.00 |
| 100 kilos at ₱1 a kilo | 100.00 |
| 150 kilos at ₱0.50 a kilo | 75.00 |
| Total gross income | 1,325.00 |
| Total expenditure | 704.00 |
| Net income per hectare | 621.00 |

# ILLUSTRATIONS

## PLATE 1

FIG. 1. A good stand of Simmaba tobacco seedlings 45 days old almost ready for transplanting.
2. Typical tobacco curing barns for cigar filler, cigar wrapper, and batek types of tobacco.

## PLATE 2

FIG. 1. A typical plant of the Simmaba variety.
2. A typical plant of the Vizcaya variety.
3. Typical leaves of the Simmaba variety.
4. Typical leaves of the Vizcaya variety.

## PLATE 3

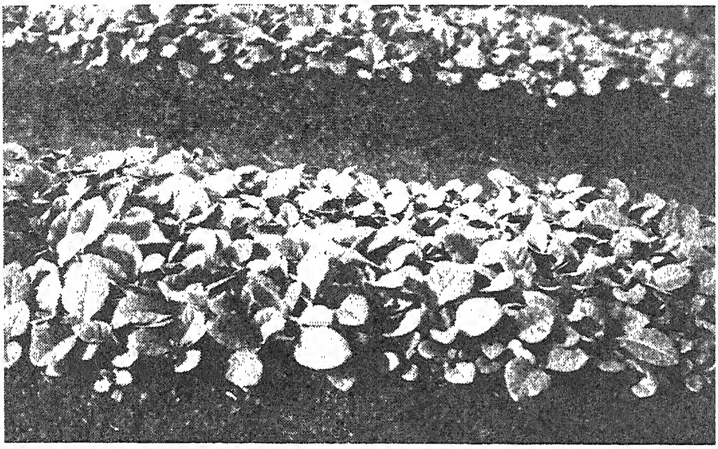
A good stand of cigar filler tobacco of the Simmaba variety.
Note that the flower heads are already cut off and the sand leaves already harvested as wrapper.

## PLATE 4

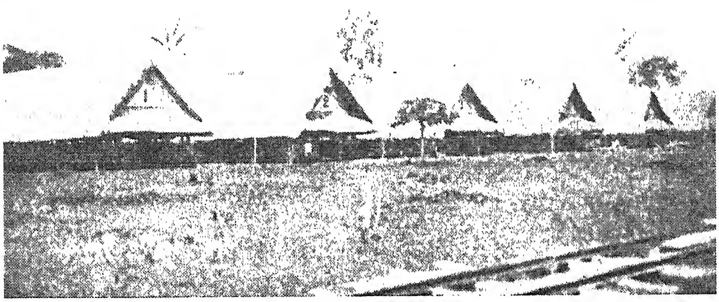
A good stand of batek tobacco with sand leaves already harvested as wrapper leaf tobacco.

## PLATE 5

A shade-grown wrapper tobacco plantation of the Vizcaya variety with abacá cloth as shade.



*1*





*2*

PLATE 1.

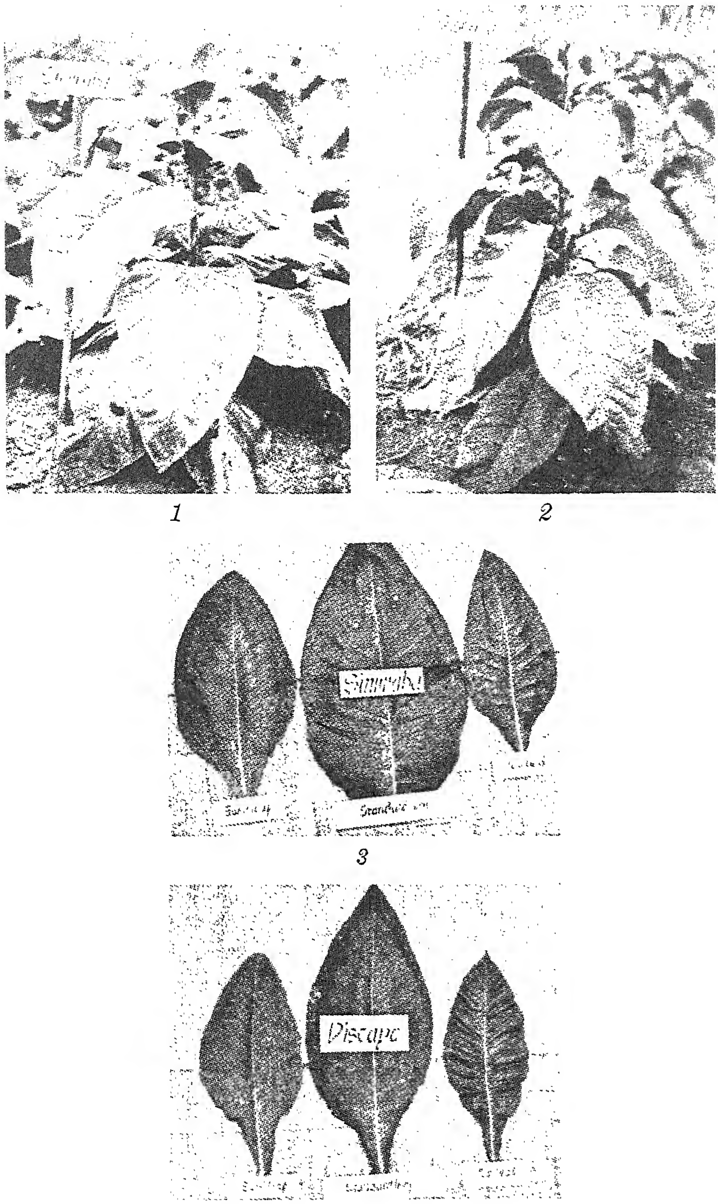



PLATE 2.

PLATE 3.

PLATE 4.

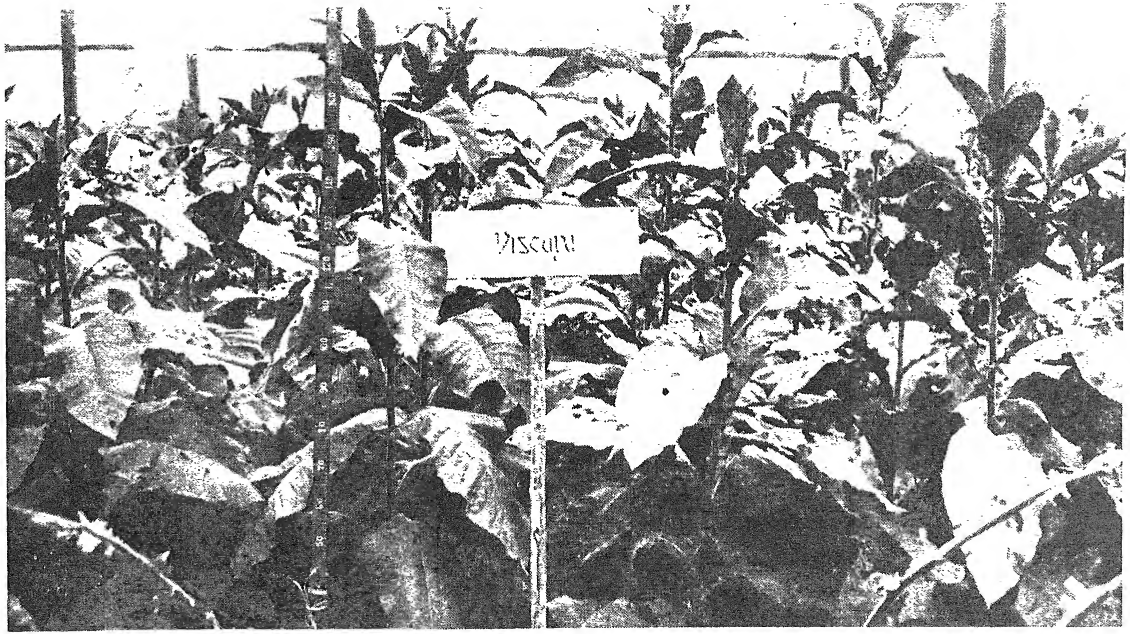



PLATE 5.

# A REPORT ON AN INSECT PEST OF WHITE AMARYLLI LILY IN THE TRINIDAD VALLEY, MOUNTAIN PROVINCE, PHILIPPINE ISLANDS[1]

By T. G. FAJARDO and J. P. TECSON[2]

*Of the Bureau of Plant Industry*

NINE PLATES

## INTRODUCTION

The white amarylli lily, *Crinum zeylanicum* Linn. is an ornamental plant which is cultivated in the vicinity of Baguio and in Trinidad Valley for its beautiful white flowers. In the Trinidad Agricultural School, this ornamental plant is more extensively grown bringing to this school a good yearly income from the sales of flowers and bulbs (Plate 1).

In November, 1933, a serious outbreak of an insect pest was noted at this school, causing considerable damage on the amarylli plants. The larvæ (Plate 7, figs. 1, 2, 3, and 4) attacked all parts of the plant, devouring the leaves, pseudostems, and the bulbs (Plates 2, 3, 4, and 5). Where the infestation was severe, the plants were destroyed within a few days. This pest was noted two or three years ago but it was then doing very insignificant damage as to warrant any measure to control it. It became very serious in 1933, and even at present, in spite of control measures practised by the school, this pest is still present.

Because this pest is very injurious, and has become established in this vicinity, a study of its life cycle, its food plants, and possible control measures was undertaken. The results are presented in this paper.

## THE INSECT AND ITS NOMENCLATURE

Comparison of the moths reared in the laboratory and of those collected from the field revealed that the insect in question is

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[1] Observation on this insect pest was started in 1933, but, because of other pressing problems its completion has been delayed. In May, 1936, the junior writer left this Bureau, and as the senior writer finds little time to carry the work further, this paper is prepared to present the salient facts thus far obtained.

[2] The writers are grateful to Dr. G. Merino and Mr. F. Q. Otanes, of the Plant Pest and Disease Control Division for kindly reading and criticizing the manuscript.

identical to the species *Glottula dominica* Cramer,[3] specimens of which were collected from Manila in 1912 by Schultze (Plates 6 and 7). Furthermore, the insect in question conforms with the description by various authors (1) (2) of the adult and larvæ of *G. dominica* Cramer. According to Moore (2) the technical description of this species is as follows:

*Adult:* "Forewing dark grayish violacious brown; discal area suffused with ochreous, and with a transverse submarginal slightly ferruginous bordered ochreous denticulated line. Across the middle are two black greyish bordered sinous lines with more or less acute greyish points on the veins, orbicular spot very indistinct; reniform spot pale, indistinctly formed with ferruginous and black streaked center; a marginal grey bordered black denticulated line; hind wing cinereous-white in male, slightly brownish along anterior border, and brownish externally in female. Thorax, head, and legs dark greyish violaceous-brown, abdomen dark cinereous-brown. Expanse, male, 1.2, female, 1.5 inch.

*Larvæ:* "Larvæ thick, warty, second to eleventh segment black, spotted with bluish-white; head, top of second segment, and the two anal segments red, with black spot; legs red; forelegs black tipped. Pupa purplish brown. Feeds on Amaryllis."

## DISTRIBUTION OF *G. DOMINICA* CRAMER

According to Hampson (1), *G. dominica* Cramer is known to occur in South Africa, Mauritius, throughout continental India, Ceylon, and Burma. In the Philippines, Schultze collected *G. dominica* Cramer in 1912 in Manila, and in 1933, it was noted doing considerable damage at the Trinidad Agricultural School. In a survey made, it has still a limited distribution and has been found only at this school.

## INJURY AND ECONOMIC IMPORTANCE

The larvæ feed voraciously on all the juicy, tender, and succulent parts of the plant. The very young larvæ have a very characteristic feeding habit. They bore into the succulent leaves and feed in the tissues in groups or form columns in one direction, leaving the thin papery epidermal tissues uneaten, thus affording them protection while developing (Plate 4). These larvaæ may remain in this condition as "leafminers" until after about the 4th instar when they are much bigger. The older larvæ are more voracious feeders and devour the leaves (Plate 6), flower stalks, pseudostems, and even the bulbs (Plates 2, 3,

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[3] The writers are grateful to Mr. G. Bellosillo, Assistant Entomologist, for comparing the adult moth reared in the laboratory with the Bureau of Science Museum specimens of *Glottula dominica* Cramer, of the family Noctuidæ. order Lepidoptera.

4, and 5). If the infestation is extensive, a full grown plant may be destroyed in a few days. The injury is most severe when the larvæ follow to feed in the inner tissues of the pseudostem, completely destroying the plant, or "setting it back," thus making it useless in so far as the production of flowers is concerned (Plate 3). The bulbs in the field or those kept in storage are also attacked, and if the injury is severe, the vigor or vitality of the plant resulting from an injured bulb is greatly reduced.

## FOOD PLANTS

The larvæ, have a narrow range of host plants on which to feed. In feeding experiments conducted in the laboratory, the larvæ fed readily on the white amarylli lily, *C. zeylanicum* Linn. and on *C. chinensis* and less on *C. asiaticum* Linn. The other plants which were tried but not eaten, or slightly eaten only, are the spider lily, *Zantedeschia acthiopica* Spring *Hemenocallis littorale* (Jacq.) Salisb., the red amarylli lily, *Atamosco rosæ* (Lindl.) Greene, *Cordyline roxleurghiana* (Schultes) Merr. *Rheæ discolor* (L. Herit.) Hance, calla lily, and croccus lily (Table 1). In this connection field observation showed that these species were not readily attacked, even if planted in the adjoining field with the amarylli plants.

TABLE 1.—*Feeding trials in the laboratory of the larvæ of G. dominica* Cramer

| Hosts [a] | Remarks |
|---|---|
| *Crinum zeylanicum* Linn. | Readily eaten and finished the leaves after 12 hours. |
| *Crinum chinensis* | Readily eaten and finished the leaves after 12 hours. |
| *Crinum asiaticum* Linn. | Less readily eaten and only small portion devoured after 12 hours. |
| *Hymenocallis littorale* (Jacq.) Salisb. | Not tasted after 6 hours and after 12 hours a small area was tasted. |
| *Atamosco rosæ* (Lindl.) Greene | Tasted but feeding was not continued. |
| *Cordyline roxleurghiana* (Schultes) Merr. | Not tasted even after 12 hours. |
| *Rheæ discolor* (L. Herit.) Hance | Do. |
| *Zantendeschia acthiopica* Spring. (Calla. Lily). | Do. |
| *Hippeastrum* sp. (Amaryllis) | Do. |

[a] Plant specimens were kindly identified by Dr. Eduardo Quisumbing, Chief, National Museum Division, Bureau of Science.

## DURATION OF LIFE CYCLE

The studies on the life history were conducted under laboratory conditions both in Manila and in Baguio. Unless otherwise

stated, the larvæ soon after hatching were reared in battery jars or in 1000 cc. beakers, the tops of which were covered with thin cheese cloth, and on the bottom about 2 inches of soil, or pieces of filter paper were placed for pupation. The larvæ were fed with leaves of *C. zeylanicum* Linn. or *C. chinensis,* while the moths were fed with cotton bolls moistened with sugar. The adults were separated or killed as soon as sufficient eggs were laid, and the other stages of life cycle were observed.

From Table 2, it will be seen that in Manila, the duration of life cycle from November to February averages from 32.5 to 34.75 days; while in Baguio, it averages from 53.25 to 61.75 days depending upon the time of the year when the experiments are conducted. It is interesting to note that in Manila when the studies were conducted from November to February, which are the cooler months of the year, the duration of life cycle was very much shorter than those conducted during the summer months in Baguio, and when the life cycle is conducted during the cooler months in the latter region, it is delayed to almost twice as long. In this connection, it was observed that the larvæ reared under Baguio conditions were somewhat bigger than those developed in Manila.

TABLE 2.—*Duration of life cycle of Glottula dominica* Cramer *under laboratory conditions in Manila and in Baguio*

| Life stages | Duration of life stages in Manila (28–30°C) | | | | Duration of life stages in Baguio (17–22°C) | | | |
|---|---|---|---|---|---|---|---|---|
| | November to December 1933 | | December 1933 to February 1934 | | February to March 1935 | | March to April 1935[a] | |
| | Min. days | Max. days | Min. days | Max. days | Min. days | Max. days | Min. days | Max. days |
| Egg stage | 5.0 | 6.0 | 4.0 | 6.0 | 12.0 | 14.0 | 10.0 | 12.0 |
| Larval stage: | | | | | | | | |
| 1st instar | 2.0 | 2.0 | 1.5 | 2.0 | 3.0 | 3.5 | 3.0 | 4.0 |
| 2nd instar | 2.0 | 2.5 | 2.0 | 2.0 | 3.0 | 3.5 | 3.0 | 3.5 |
| 3rd instar | 2.0 | 2.5 | 1.5 | 2.0 | 4.0 | 4.5 | 3.0 | 3.5 |
| 4th instar | 2.5 | 3.0 | 2.0 | 2.0 | 4.0 | 4.5 | 3.0 | 3.5 |
| 5th instar | 2.0 | 3.0 | 2.5 | 3.0 | 5.0 | 5.5 | 4.0 | 5.0 |
| 6th instar | 5.0 | 6.0 | 4.5 | 5.0 | 6.0 | 7.0 | 5.0 | 6.0 |
| Pupal stage | 8.0 | 10.0 | 9.0 | 10.0 | 18.0 | 20.0 | 15.0 | 17.0 |
| Adult stage | 1.0 | 5.0 | 1.0 | 5.0 | 1.0 | 5.0 | 1.0 | 5.0 |
| Total | 29.5 | 40.0 | 28.0 | 37.0 | 56.0 | 67.5 | 47.0 | 59.5 |
| Average | 34.75 | | 32.5 | | 61.75 | | 53.25 | |

[a] Average from two series conducted simultaneously.

## DESCRIPTION OF STAGES

In the above study, although differences were noted in the size and duration of life stages, little difference was observed in the characteristic markings of the different stages. For this purpose, the description of the stages are taken from one of the series conducted in Manila as follows:

### I. THE EGG STAGE

The eggs are 0.6 to 0.7 mm. in diameter. In the laboratory, they were laid singly or in groups in irregular masses on the sides of the container, or on pieces of paper when present, while in the field, they are generally laid irregularly on the surface of the leaves. When viewed from above, they are circular, but from the side they are elliptical and slightly flattened on the side of attachment. When newly laid, the eggs are bright yellow, but later become light colored with a black dot on the region of the micropyle which indicates the head of the young embryo larva. When the egg hatches, the larva comes out first by its head and frees itself by wiggling.

### II. THE LARVAL STAGES

*First instar.*—The first instar larvæ soon after hatching are weak and move very little. They are from 1.5 to 2.5 mm. long by 0.3 to 0.5 mm. wide. Later on, they seek their food, bore and feed in the leaf tissues between the epidermal layers. The head is prominent, brown, with two brown eyes. The body is whitish-brown with short fine hairs, but later it becomes yellowish-brown. After a day, the head becomes shiny, brownish-black, almost as wide as the body. The prothorax is yellowish-brown; prolegs brown; abdomen yellowish-green becoming lighter at the posterior end; the last two posterior segments brown; body dirty white with yellow tinge.

*Second instar.*—The larvæ are from 4.0 to 6.0 mm. long and 0.7 to 0.8 mm. wide. They are yellowish brown with brown bands around the body. The head, with two black eyes is yellowish brown to reddish-brown, with two small black dots on the dorsal side of the head and another pair on the yellowish-brown prothorax. The body is reddish-brown with creamy white spots around the body segments from the 2nd to the 11th segment. The prolegs are dark brown, and abdominal legs and anal segments yellowish-brown with dark brown band.

*Third instar.*—The larvæ are from 5.0 to 7.0 mm. long by 0.8 to 1.0 mm. wide. At first they are yellowish-brown but later become generally brownish-black. The head and prothorax are reddish-brown, with four black dots on the dorsal side and another pair on the lateral side with hairs; the bluish-white spots on the body are much enlarged. The body hairs are longer and darker. The true legs are black, the false legs yellowish-brown with a dark-brown band. The two anal segments are yellowish-brown with black areas on the dorsal part.

*Fourth instar.*—The larvæ are from 13.0 to 14.5 mm. long by 2.0 to 2.5 mm. wide. They are cylindrical, thick, brownish-black with the black color alternated with the bluish-white spots from the 2nd to the 11th segment. The head and prothorax have the same characteristics as the 3rd instar. The posterior end tapers a little and is reddish-brown marked by four dots. They feed voraciously and increase in size rapidly. At this stage, they lose their tunnelling habit.

*Fifth instar.*—The larvæ are from 22.0 to 25.0 mm. long by 4.0 to 6.0 mm. wide, and have identical markings as the 4th instar larvæ. They are at first yellowish-brown, but later become brownish-black with more distinct bluish spots. The head and prothorax are reddish-brown, antennæ yellowish-brown; the true legs black; the false legs yellowish-brown with a dark-brown band. The body is dark-brown, with bluish spots alternated from the 2nd to the 11th segments; hairs sparse; the posterior end reddish-brown at the base with a dark band.

*Sixth instar.*—The larvæ are from 27.0 to 35.0 mm. long by 4.0 to 6.0 mm. wide, and are identical to the 5th instar larvæ. They are at first yellowish-brown, but later become brownish-black. They feed voraciously and increase in size rapidly and become more bulky and warty. The full-grown larvæ are from 36.0 to 50.0 mm. long by 6.5 to 8.0 mm. wide. When about to pupate, the larvæ refuse to eat, or eat only sparingly. They are sluggish, contract, bury, and build an earthern cell. They may pupate without encasement or they may use only filter papers. In the field, however, they may pupate in the ground.

### III. THE PUPAL STAGE

The pupæ are generally cylindrical, segmented, and abruptly tapered at the posterior end. They are at first yellowish-brown, but later become purplish-brown. They are from 20.0 to 30.0 mm. long and 7.0 to 8.0 mm. wide. Before the adult emerges, the joints of the pupæ are stretched, and the head comes out

by breaking through the posterior end. By continuous wiggling, the adult soon frees itself from the pupal case.

### IV. ADULT STAGE

After emergence, the moth is weak, but a few hours later, it can move or walk or fly. After a day, the female begins to lay eggs and may lay as many as 500 eggs during its life period which is from 3 to 6 days depending upon certain conditions. Copulation, and oviposition generally take place at night.

The adult female is grayish-black and is generally larger than the male. It is 17.0 to 19.0 mm. from the head to the posterior end of the abdomen and 5.5 to 6.0 mm. wide on the thorax. The head is fair in size; covered with black hairs; possesses a pair of gray eyes and two prominent reddish antennæ. The thorax and legs are covered with numerous dark grayish-brown hairs; abdomen grayish-black. The forewing expanse is from 40.0 to 44.0 mm., dark grayish-violet-brown, the central portion obscured. On the margin is a gray black denticulated line. The hind wing has distinct venations, brownish-black along the borders and lighter in color about the base.

The adult male is smaller than the female and measures from 14.0 to 17.0 mm. from the head to the posterior end of the abdomen, and 4.5 to 5.0 mm. wide on the thorax. The forewing expanse is 36.0 to 38.0 mm. In general, the male is similar to the female, except that the hindwing is lighter with dark-brown shades on the apical end.

## EXPERIMENTS ON CONTROL METHODS

*Control by chemical methods.*—In a series of experiments, lead arsenate, dry Bordeaux mixture, dry lime sulfur, and sulfur flower were applied either by dusting on the larvæ or by feeding the larvæ with the leaves dusted with the poison. The larvæ were then confined in mason jars or in 1,000 cc. beaker, the top of which were covered with cheese cloth, and after 24 hours, the percentage of kill was determined. The results which are summarized in Table 4 show that lead arsenate powder applied on the leaves, or dry fungi Bordeaux and dry lime sulfur applied on the larvæ killed all the larvæ after 24 hours, while flower of sulfur dusted on the larvæ, or dry Bordeaux or lime sulfur dusted on the leaves did not have any effect at all. The check larvæ, which were not treated with any poison were still alive after 96 hours.

In another series, 0.2, 0.5, 1, 2, and 5 per cent solutions of lead arsenate were thoroughly sprayed each on 1 foot of amarylli leaf, and then 5 larvæ reared from the laboratory were allowed to feed on each leaf and put into separate containers. After 2 hours, those fed on leaves sprayed with 0.2, 0.5 or 1 per cent were still alive and continued to feed, while those fed on 2 and 5 per cent became sluggish and ate only a small portion of the leaf. After 22 hours, the leaf sprayed with 0.2 per cent solution was all eaten but only one of the larvæ died; the leaf sprayed with 0.5 per cent was not all eaten but 2 larvæ died; while the leaves sprayed with 1, 2, and 5 per cent were each eaten in a small area, but all the larvæ were killed. The check, in which the same age larvæ were fed with unpoisoned leaves, continued to live and feed vigorously until the end of the experiment.

TABLE 3.—*Studies on chemical control of G. dominica* Cramer

| Chemicals used | Methods of application | Number of larvæ treated | Number of larvæ dead after 24 hours |
|---|---|---|---|
| *Series I* | | | |
| Lead arsenate | Leaf dusted [a] | 10 | 10 |
| Dry Fungi Bordeaux | do | 5 | 0 |
| Dry lime sulphur | do | 5 | 0 |
| Sulfur flower | Worms dusted | 10 | 0 |
| Dry Fungi Bordeaux | do | 10 | 10 |
| Dry lime sulphur | do | 10 | 10 |
| Check | No treatment | 10 | 0 |
| *Series II* [b] | | | |
| Lead arsenate: | | | |
| 0.2% solution | Leaf sprayed | 5 | 1 |
| 0.5% solution | do | 5 | 2 |
| 1.0% solution | do | 5 | 5 |
| 2.0% solution | do | 5 | 5 |
| 5.0% solution | do | 5 | 5 |

[a] The larvæ were allowed to feed on the leaves dusted with the poison.

[b] Leaves were sprayed with the corresponding lead arsenate solutions and then allowed the larvæ to feed.

*Control by an insect parasite.*—The egg parasite, *Trichogramma minutum,* is a potential parasite on the egg of *G. dominica* Cramer. In a series of experiments conducted in the laboratory in Baguio, several adults of this beneficial insect were liberated in a test tube containing 30 eggs of *G. dominica* Cramer reared in the laboratory. As check, another test tube with 20 eggs was used but no parasite was liberated. After 20 days, the eggs where *T. minutum* was liberated failed to hatch, while the

check gave a high percentage of hatch after 12 to 15 days. In this connection, a set of liberation of this useful insect was undertaken in the field, but, because of the drastic cutting of leaves and digging up of plants as a means of control practised by the Trinidad Agricultural School, *T. minutum* did not have much chance to get well established.

*Control by an entomogenous fungus.*—In limited inoculation experiments and observations in the field, a species of an entomogenous fungus was found responsible for the death of certain number of larvæ in the field. This is especially true during the moister months of the year when the fungus becomes very prevalent. These parasitized larvæ usually first become sluggish, pale or yellowish, and later die, and from these dead larvæ, whitish aerial mycelia, and greenish masses of pulverulent spores are abundantly produced (Plate 7, figs. 5, 6, 7, and 8).

TABLE 4.—*Natural field infection of larvæ of G. dominica* Cramer *by an entomogenous fungus (Collected August 9, 1934)*

| Number of cultures | Number of dead larvæ and date of observation | | | | | | | Larvæ pupated Aug. 18 |
|---|---|---|---|---|---|---|---|---|
| | Aug. 11 | Aug. 13 | Aug. 14 | Aug. 15 | Aug. 16 | Aug. 17 | Aug. 18 | |
| Culture 1: | | | | | | | | |
| 10 larvæ | 1 | -------- | 2 | -------- | -------- | -------- | -------- | [a] 7 |
| Culture 2: | | | | | | | | |
| 10 larvæ | -------- | -------- | 2 | 2 | -------- | -------- | -------- | [a] 6 |
| Culture 3: | | | | | | | | |
| 12 larvæ | -------- | 2 | -------- | -------- | 1 | 3 | -------- | [b] 6 |
| Culture 4: | | | | | | | | |
| 20 larvæ | -------- | 1 | -------- | 2 | -------- | -------- | 2 | [c] 15 |

[a] On September 9, 1934, the pupæ were moldly-attacked by the entomogenous fungus—and none emerged.

[b] Only one emerged and the other rotted and moldy.

[c] On September 10 only 3 emerged (male) and the rest rotted and moldy.

In order to obtain information on the number of larvæ becoming naturally infected in the field, 52 medium-sized larvæ were collected in the Trinidad Agricultural School on August 9, 1934, and were brought to Manila for observation. The larvæ were divided into 4 lots and each lot placed in a separate container. The larvæ were fed with *C. chinensis* obtained from Manila. As shown in Table 4, the larvæ began to die after a few days and out of 52 larvæ observed, 18 died during the larval stage, a few died during pupation period, and the others pupated normally and emerged into adult moths. From these dead larvæ

and the pupæ which failed to emerge, there developed the characteristic fungus growth when placed in a moist petri dish and incubated at 28°–32° C, or left at room temperature. In another series, collections were made in January, but at this time observations were made in Baguio. Infected larvæ were again noted, but the percentage of infection was low.

In addition to this observation, inoculations were made on laboratory-reared healthy larvæ with spores,[4] produced from the dead larvæ obtained from the field. The larvæ after inoculation were then placed in separate containers and fed with leaves of *C. zeylanicum* Linn. and *C. chinensis*.

In one set of experiments, one healthy larva was inoculated on November 23, 1934, by brushing the spores on the central ventral, on the dorsal part, on the dorsal side, and on the ventral side. Simultaneously with this experiment, four larvæ were inoculated by allowing them to feed on a piece of leaf dusted or sprayed with the fungus spores. As check, one larva of the same age was used, but the spores were not applied. With this series, the larva inoculated by brushing the spores on the dorsal side died after 6 days. The larva inoculated by brushing the spores on the central ventral part, or that one allowed to feed on the leaf inoculated by spraying, pupated incompletely and died. The larva inoculated by brushing the ventral side pupated, but died in the pupal stage. The larva inoculated on the dorsal side remained healthy and pupated normally as did the check. All these dead ones when placed in petri dishes and incubated at 28° 32° C. became covered with the mycelia of the fungus from which the typical greenish white masses of spores were produced. In another series, identical results were obtained in which two larvæ were immersed in a suspension of spores, with the death of the larvæ occurring within a few days. In this experiment the check larva which was only immersed in water pupated normally and emerged into a healthy adult female. From this limited observation and inoculation experiment, this fungus is undoubtedly pathogenic, and caused the death of certain number of the larvæ in the field under field conditions.

*Control by other measures.*—With the appearance of this pest in 1933 various methods of control have been tried at the Tri-

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[4] This fungus has been cultured on artificial media, but failed to sporulate abundantly with the various media tried. So far no attempt has been made to determine its taxonomy.

nidad Agricultural School. Among those which were tried and proved very practical are: (*a*) cutting off and burying the infected leaves one-half meter deep; (*b*) cutting and burning infected leaves; (*c*) hand picking of worms or cutting infected leaves and crushing the worms; (*d*) digging up of the infested plants, removing all the leaves and then transplanting them into another field far from the infested plot; and (*e*) attracting the moth at night with torches.

From the results of these studies, the larvæ can be controlled by various means. Lead arsenate in powder form or in solution of 0.5 to 1 per cent or more applied on the leaves at the proper time is less expensive. The various other control measures, such as digging up of the plants, cutting of infected leaves and burying or burning them, and picking and crushing the larvæ are very practical and satisfactory, but these are tedious, very expensive, and rather harmful in view of the fact that by continuous digging and transplanting of the plants or cutting of the leaves, the plants are generally "set back" or stunted in growth (Plate 9). The control by means of the egg parasite, *T. minutum,* or by a species of an entomogenous fungus was shown to kill the eggs and larvæ, respectively.

## SUMMARY

1. An insect pest, *Glottula dominica* Cramer, is reported serious on amarylli lily, *Crinum zeylanicum* Linn., in Trinidad Valley, Mountain Province.

2. It was found affecting the amarylli plants in Trinidad Agricultural School.

3. The larvæ are voracious feeders, and devour the leaves, flower stalks, pseudostems, and even the bulbs. They feed more readily on *C. zeylanicum* Linn. and *C. chinensis*.

4. The duration of life cycle under laboratory conditions in Manila is shorter than in Baguio. In Manila it ranges from 28 to 40 days, while in Baguio it is from 47 to 67.5 days, depending upon the months of the year when the studies were made.

5. Various methods of control have been tried. Lead arsenate in powder form or in solution of 0.5 to 1.0 per cent or more is very effective, especially on the larger larvæ when they feed on the leaves.

6. Collecting the worms and cutting off the infected leaves and burying or burning them are also very effective.

7. The egg parasite, *T. minutum* and a species of an entomogenous fungus were found to attack the egg and the larvæ of *G. dominica* Cramer respectively.

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2. F. MOORE. The Lepidoptera of Ceylon. L. Reeve & Co., London. 1884–7. Vol. 3:14.

# ILLUSTRATIONS

PLATE 1

Section of a field of amarylli lily *Crinum zeylanicum* Linn. at the Trinidad Agricultural School.

PLATE 2

Section of a field of amarylli lily *C. zeylanicum* Linn. infested in September with the larvæ of *G. dominica* Cramer. The field was severely infested and nearly every plant was attacked and destroyed, so that the sales of flowers from the school was reduced to nil.

PLATE 3

Amarylli lily plants, destroyed by the larvæ of *G. dominica* Cramer. The terminal shoot and other succulent tissues are attacked.

PLATE 4

Closer view of an amarylli plants attacked by the larvae of *G. dominica* Cramer. Note that in some of the leaves, the papery thin epidermis are not eaten (at x). Between these layers, may be found the very young larvæ which feed in the tissues in columns or in groups.

PLATE 5

Amarylli plants severely attacked by *G. dominica* Cramer. In fig. 1, the larvæ started to bore through or across the pseudostem, while in fig. 2, the young terminal shoot and the succulent tissues inside were almost eaten up. These plants are useless in so far as the production of flowers for the season is concerned.

PLATE 6

Feeding injury on the amarylli leaves by the larvæ of *G. dominica* Cramer. Fig. 1 is an old leaf eaten up by larvæ, and fig. 2, a succulent leaf eaten up by the larvæ.

PLATE 7

Full grown larvæ of *G. dominica* Cramer. Figs. 1, 2, 3, and 4 are healthy larvæ, while figs. 5, 6, 7, and 8 are attacked and killed by a species of an entomogenous fungus. From these parasitized larvæ, abundant greenish white spores are produced.

PLATE 8

*G. dominica* Cramer showing certain stages of the insect. Fig. 1, adult male; Fig. 2, adult female; Fig. 3, larva about to pupate; Figs. 4 and 5, pupæ; Fig. 6, eggs; Fig. 7, full grown larva.

PLATE 9

A section of amarylli field after general cleaning, collecting the worms, and cutting and burning of the leaves as means of control done. This field was previously severely infested by *G. dominica* Cramer.

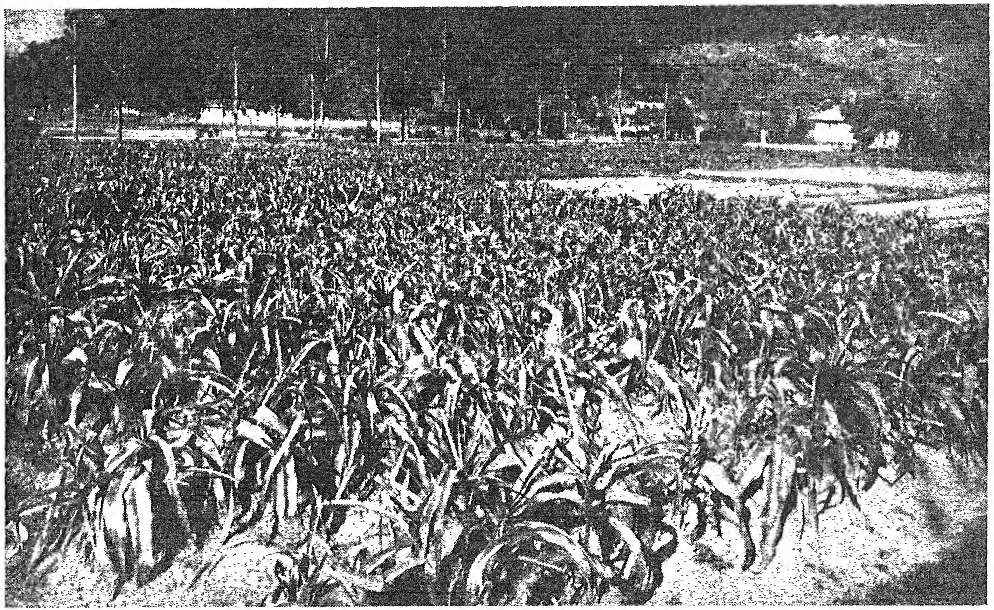

PLATE 1.

PLATE 2.

PLATE 3.

PLATE 4.

PLATE 6.

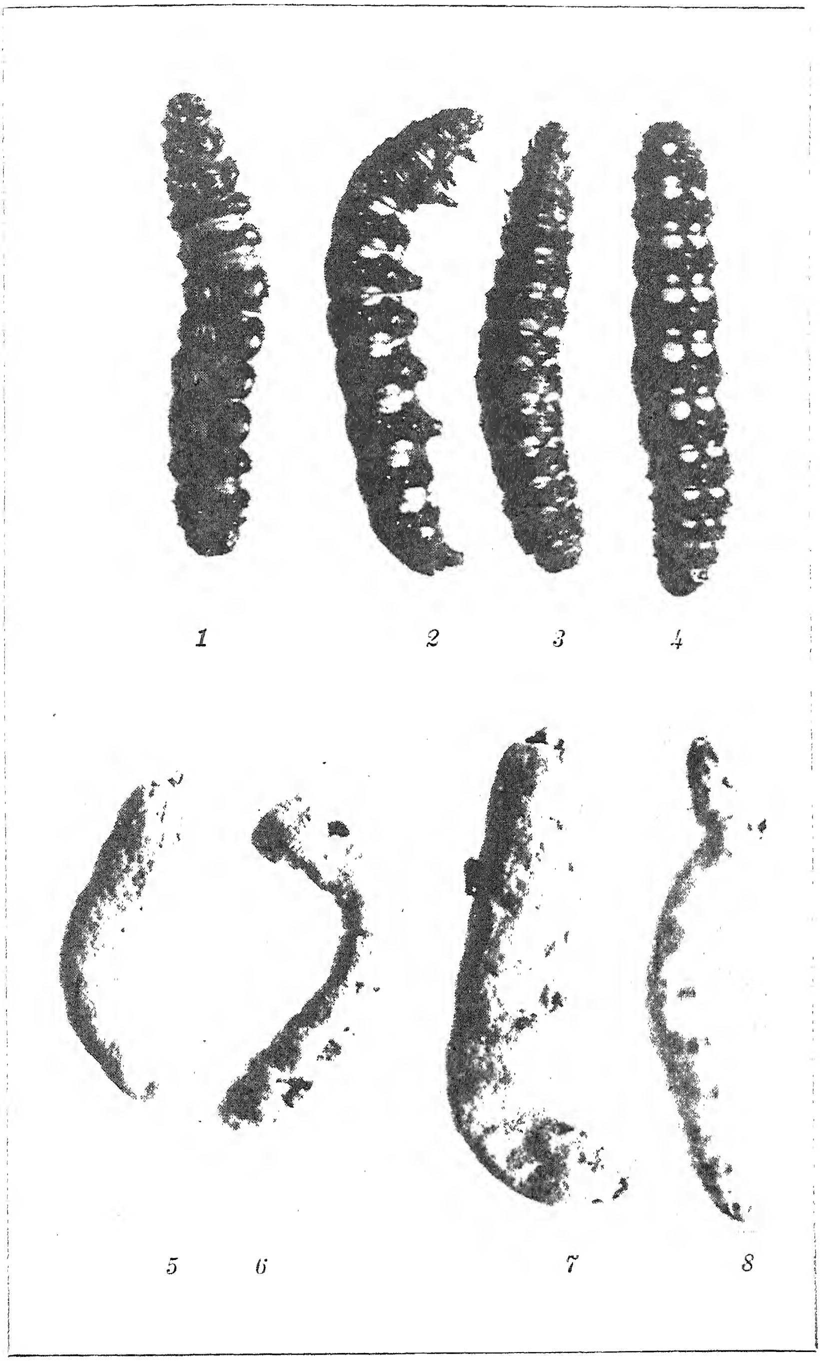


PLATE 7.

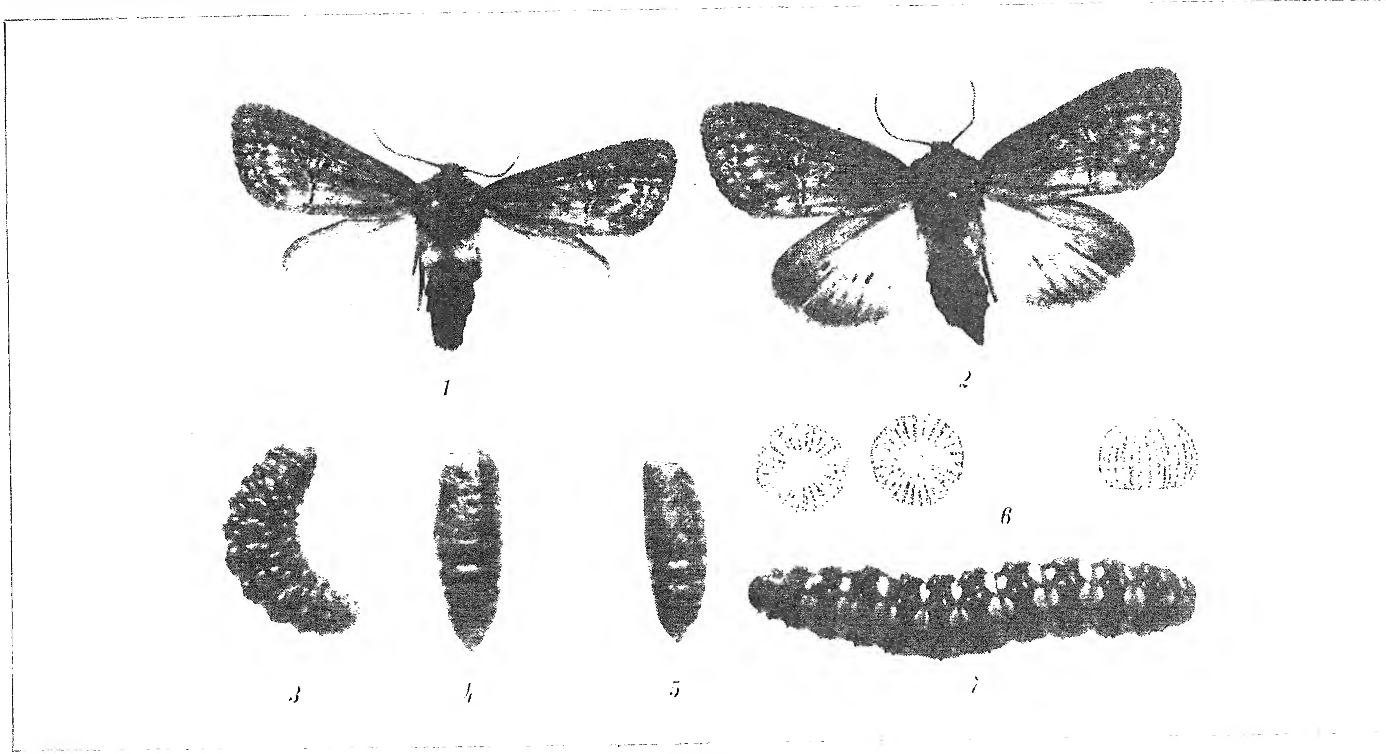


PLATE 8.

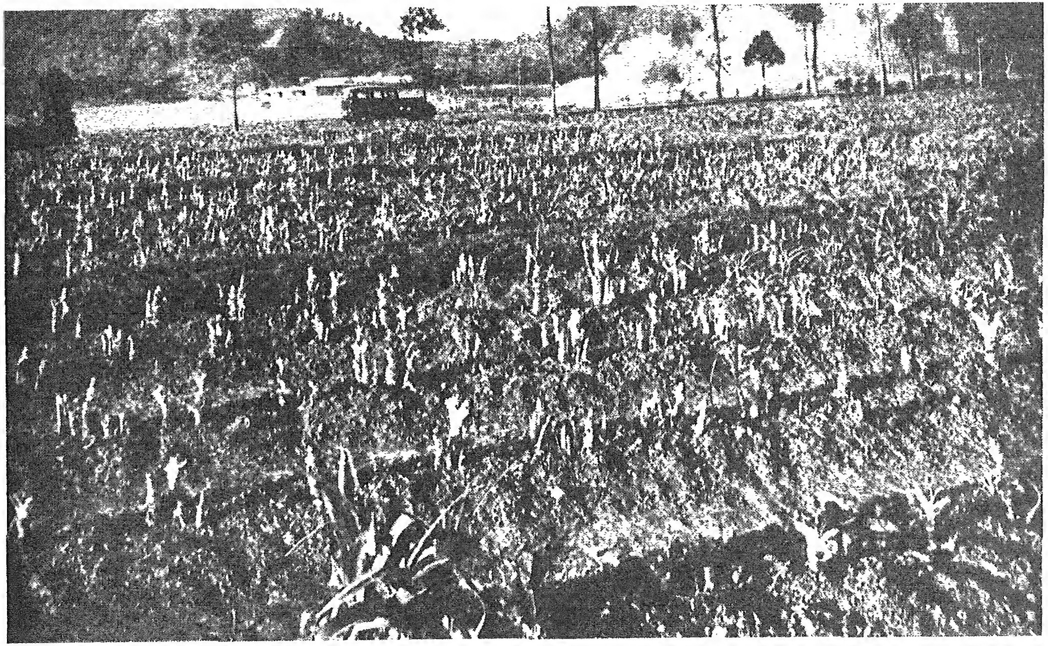

PLATE 9.

# FARMERS' CIRCULAR SECTION

# THE LANZON (*LANSIUM DOMESTICUM*, JACK)

(Farmers' Circular 6)

By ADRIANO M. ORGAS
*Assistant Agronomist*

TWO PLATES

The lanzon is known in the Philippines under many different names: *Lansones* (Tagalog and Bicol), *budhaw, boboa, bukan. buluhan* (Bisaya) ; *buahan* (Mbo., Sul.) ; *buan, malibongan, kalibungan* (Mbo.) ; *tubua* (Bag.) ; *bogko* (Bukidnon). In other places, it is called *langsat, langsep,* and *rambai.* In Malaya it is called *lanseh* or *lansa.* It is known in science as *Lansium domesticum* Jack, family *Meliaceæ.* Lanzon is one of the most wholesome and delicious fruits of this country. About one-half of the number of trees under cultivation is found in Laguna. The main lanzon regions in this country are located in the humid belts of the provinces of Laguna, Bukidnon, Albay, Tayabas, Samar, Mindoro, Oriental Misamis, Zamboanga, Davao, Lanao, Leyte, Sulu, Batangas, etc. However, in other parts of the Philippines like Bulacan, Pampanga, Iloilo, Cebu, and Manila, where the underground water is shallow, the lanzon is also grown with a fairly good success.

## VARIETIES

Variations in the so-called varieties or types, for which six types of lanzon have been described by Mendiola, are distinguished by the shape of the fruits, size of the seeds, amount of milky juice in the flesh rind, and the sweetness or sourness of the fruits. It is said that the *duku* is a distinct variety of lanzon which is larger than the Philippine lanzon and is grown extensively in Malaya and Java. As in the Philippines, the lanzon grows wild in Java where three varieties are known; namely, *daeke, bigjitan,* and *kokosan.*

As to shape of fruits, two so-called varieties are recognized in the Philippines. These are the round and the elongated. The elongated is generally, if not always, a sweet variety.

Sweetness also is usually indicated by a blackish and purplish area at the base of the fruit around the stem. Lanzon fruits from trees grown in Paete and San Pablo, Laguna, are well known for their sweetness.

### SOIL AND CLIMATIC REQUIREMENTS

Lanzon thrives best in districts where there is a uniform distribution of rainfall and in places where dry and wet seasons are distinct, and where the ground water is shallow, like that in Angeles, Pampanga. A site comparatively exempt from typhoons and strong winds, from sea level to about 2,000 feet elevation, and where the soil is loamy and well drained, is an ideal place for lanzon growing. Strong winds are bad especially when the trees are laden with flowers and fruits. In Paete, Laguna, where sweet bearing lanzon trees are found, the soil is clay loam admixed with boulders, with natural irrigation, but well drained due to the topography of the land.

### PROPAGATION

Lanzon is either propagated by seed or vegetatively by grafting, marcotting, and budding. Before the vegetative methods of propagation, such as grafting and marcotting came to be used, propagating by seed was the only means employed by the growers, but trees propagated by this means take too long a time before bearing. Trees grown from seedlings are said to come into bearing in 12 to 20 years from the time of planting. The importance of vegetative methods of propagation of lanzon cannot, therefore, be overemphasized, since plants propagated vegetatively usually come into bearing earlier than seedling trees, and moreover, the quality of fruit is assured.

*By seed.*—The seeds are cleaned of any adhering flesh by washing them with fresh water. Then they are air-dried for some time before planting. This treatment is necessary in order not to allow adhering flesh to ferment and get moldy or otherwise attract ants to the sugary flesh of the seeds. The seeds should first be planted closely in seedbed and covered with soil about 1 centimeter deep. The seedbeds should be under partial shade. As a rule the seeds will germinate in from one to three weeks. When the seeds have completely germinated and the seedlings are about six inches high and have at least two

pairs of leaves, they should be pricked in nursery beds, spacing them 40 to 50 centimeters apart. In this way, they should be allowed to grow from 1½ to 2½ years and then they can be set out in the fields. The seedlings can also be planted in bamboo tubes when they are about a month old, and shipped to distant places with little possibility of injury in transit.

*By grafting.*—This is the best way of propagating lanzon, and is done by cleft grafting, using terminal, well matured, and non-petioled scion of the same age as the stock. The scion should be about 1 centimeter in diameter or about the size of a lead pencil and 6–10 centimeters long containing at least 3 or 4 buds. Usually, in case of freshly cut scions, they are first furred in seedbeds mostly sandy in nature and allowed to remain there for a month or so until buds have protruded about 4 to 6 millimeters, when they are then ready for insertion. These scions should be grafted on when they are at the point of callousing, fresh and sound ones being selected. Grafting should be done during the wet season. The trunk of the stock should have a diameter of the size of a lead pencil also or a bit bigger than the scion. Lanzon seedlings are ready for grafting at the age of from 2½ to 3½ years. Grafted plants begin to bear in 7 years from planting in the permanent field.

*By marcotting.*—Marcotting is one of the oldest methods of vegetative propagation and has been used successfully with many trees including the lanzon. The Filipino fruit growers are familiar with it, especially in propagating chico. Marcotting is performed by ringing a branch or twig while it is attached to the parent plant, and then applying soil to the ringed section to induce root formation. Branches about 1½ to 2 inches in diameter are used for this purpose. "Cabo negro" fiber (*Arenga saccharifera*) or coconut husk is used for wrapping and holding the ball of soil around the girdled section. The soil should cover the girdled portion completely. Fine wire should be used for tying the "cabo negro" fiber or coconut husk to hold it in place and keep it compact, and to afford greater security. The marcotted branch should be watered as often as necessary. Rooting will take place in about two months after marcotting, and the marcots may be severed from the mother plant in 5 to 6 months when the secondary roots shall have matured, and penetrated through the wrappings. Care must be exercised not to

marcot too many branches on one tree. Unlike the chico, lanzon is a delicate tree. On a commercial basis, this method is impractical as it would need many trees to do the marcotting on. The best time to marcot is at the beginning of the rainy season. Some marcotted plants come into bearing at the second year.

*By cutting.*—Propagation by cutting may be used with the lanzon. This recommendation is made only to experienced nurserymen. Over 50 per cent success could be attained under ideal conditions. This method may be described as follows: Beds with a depth of 25 centimeters and at convenient length are prepared under the shade of trees by digging out a considerable portion of the soil and then replacing it with enough medium-coarse, fresh-water sand. The sand may be leveled and packed firmly with a spade. Fairly well matured wood should be used for cuttings. With pruning shears, the branches should be trimmed off close to the stem and both ends cut slantingly with a sharp knife taking care not to bruise the wood. The cuttings should be placed in porcelain jars having a capacity of 1,000 cc. Two hundred cubic centimeters of 1.5 to 2 per cent potassium permanganate solution should be poured into each jar, immersing about 2 centimeters of the basal ends of the cuttings in the solution. After about 24 hours of immersion the cuttings are set in the beds. The ends of the cuttings should not be bruised. Then the cuttings are placed in the holes about $\frac{2}{3}$ of their length, in a slanting position. To keep them in position, the sand is pressed gently around the cuttings. The cuttings may be transplanted directly to the nursery rows after they have made a well established root system in the beds, which may be made four months after setting.

## PREPARATION OF LAND AND PLANTING

When a forest land is used, the general practice is to cut down the trees and burn them as they become dry, leaving the stumps to decay. The land is then planted without first being plowed. The land should be planted with cover crop so as to check the growth of weeds.

*Shade trees.*—The lanzon plant needs a little shade for its proper development. For this reason such shade trees as madre-cacao and ipil-ipil may be used during the early stage of their

growth and later thinned so as not to interfere with the full development of the branches of the lanzon. For purposes of dual farm income avocado and breadfruit may also be planted as shade trees. Temporary shade trees may be planted during the early life of the plantation until the permanent shade trees have been established. In Paete, Laguna, santol trees are used as shade, thereby having two crop plants on the same piece of land. It has been found, however, that shaded trees give not a little more yield than unshaded trees.

*Planting.*—Seedlings when about two to three years old or vegetatively propagated plants are generally set out in the field at least 7 by 7 meters apart. The size and depth of the holes in which to plant the seedlings will depend upon the size of the seedlings, the kind of soil, and the size of the bolled earth around the root system. The plants should not be planted deeper in the field than they were in the nursery.

### CARE AND CULTIVATION OF PLANTATION

Cultivation in the form of ring weeding and shallow hoeing around the plant to a radius of at least one meter should be done at least 2 times a year during the early life of the lanzon plants. The plants should be mulched during the dry season in order to conserve the moisture of the soil.

### PRUNING

Judicious pruning should be practised from the time the lanzon trees are about 4 or 5 years old to get a fine formation of trunk and branches. Sharp pruning tools should be used, and cuts or wounded parts should be painted with white lead or coal tar. Pruning should be done only during the dry season.

### HARVESTING

The fruit ripens in about 5 to 6 months from the time of flowering which takes place in June, particularly under Laguna conditions. In picking, the matured fruit should never be pulled off as to injure that portion in which the bunch is attached because it is within this region where the second "set" of fruit

develops. A sharp knife or shears should be used in clipping off the bunches. The fruit should not be picked before it is fully matured.

Seedling trees 30 years old yield a little over 1 "kaing," while trees 55 years old yield about 3 "kaings" on the average. A "kaing" of lanzon contains about 1,500 to 2,500 fruits.

The supply of lanzon fruits is most abundant in Luzon from the middle of September up to October and in Mindanao from January to February.

## PESTS AND DISEASES

Lanzon trees are troubled by "dapu" (*Loranthus*) and some caterpillars and mites that feed in the bark. Lichens are also troublesome if abundant. Root disease also attacks both young and old trees.

*"Dapu" (Loranthus)*.—This is a parasite that is found growing on the lanzon plant. It attaches itself to the plant by means of its small projections which absorb water and other food substances from the host plant. This parasite produces sticky seeds which the birds may disseminate among the trees by rubbing them off their beaks on the bark. This can be controlled by simply cutting off the affected twigs and burning them.

*Caterpillars and mites.*—To control these pests, scrape or clean the affected parts and apply concentrated lime sulphur or lime sulphur sludge. The lime sulphur may also be used against the lichens as a spray.

*Root Disease.*—This disease attacks both the young and old trees, but the older ones succumb more easily to the malady.

Externally, the early stage of the disease on the above-ground parts of the plants in the field is characterized by the yellowing and wilting of the leaf and the gradual falling off of the younger leaves and then of the older ones. The petiole easily breaks off.

In the soil the disease travels from the small lateral roots toward the bigger ones and then to the base of the stem causing a gradual decay. The roots rot and usually are distinctly brownish black in parts, but in severe cases the marked absence of roots as a result of the disease is especially noticeable. This naturally results in the death of the plant from lack of food and water.

In the advanced stage of the disease all the roots decay up to the base of the stem, and then comes the death of the tree. Where the infection is severe all the leaves wilt very quickly, yet persist on the plant for a number of days or even weeks. Later the tree is defoliated. The roots, trunk, and branches gradually dry up. A wet, white, cottony mycelium, visible to the naked eyes, penetrates the wood and disintegrates the tissues of the decayed roots, which easily break off and look very different from the healthy portions.

The disease may be controlled by the following methods:

1. Destroying all diseased materials, such as stumps and rotten logs and burning them.
2. Cutting off the affected lateral roots as well as that portion of the top root which shows the presence of fungus.
3. Applying unslaked lime in 2 or 3 feet deep trench around the diseased tree, after washing the affected portions with a four per cent formalin solution, the idea being to isolate affected trees from the healthy ones.
4. Employing good cultural practices, such as proper cultivation, drainage, sanitation, etc.

## CHEMICAL CONSTITUENTS OF RIND, SEED, ETC.

The flesh of the fruit contains 1.13 per cent protein, 13.00 per cent sugar and 0.59 per cent ash. It is believed that the rind and seed contain some chemical constituents which are medicinally and industrially important. The outer skin is bitter and is regarded as very rich in tannin. No definite use for the seed and the rind has been satisfactorily found so far. However, the peninsular Malays use the juice of *langsat* for treating sore eyes, the decoction of its bark and leaves for treating dysentery, and the powdered bark as a remedy for scorpion stings. In our country, generally the rind is dried and burned inside the house for the purpose of driving away mosquitoes by means of the smoke; it is given preference over other remedies because of the pleasant odor emitted on burning. It is said that the inhalation of the smoke of the rind has a soothing effect on tuberculous persons, and a decoction of the branches is sometimes used as a stomachic.

## FARM MANAGEMENT

*(a) Estimated cost of bringing into bearing one hectare of lanzon plantation*

| Items of operation | Man | Approximate cost |
|---|---|---|
| | *Day* | *Pesos* |
| First year: | | |
| 1. Cost of 204 lanzon seedlings at P0.10 each | | 20.40 |
| 2. Clearing the jungle | 75 | 75.00 |
| 3. Burning the debris | 6 | 6.00 |
| 4. Staking | 4 | 4.00 |
| 5. Planting shade trees (both temporary and permanent) | 6 | 6.00 |
| 6. Cost of seeds of shade trees | | 2.00 |
| 7. Digging holes (204 at 7 x 7 m.) | 20 | 20.00 |
| 8. Distributing the seedlings in the field | 1 | 1.00 |
| 9. Planting seedlings in permanent field | 4 | 4.00 |
| 10. Weeding with hoe (2 times during the rest of the year) | 16 | 16.00 |
| 11. Replanting, materials and labor | 1 | 3.00 |
| Total expenses for the first year | | 157.40 |
| Second year: | | |
| 1. Replanting, materials and labor | 1 | 2.00 |
| 2. Ring weeding (4 times) | 12 | 12.00 |
| 3. Thinning shade trees and mulching | 6 | 6.00 |
| Total expenses for the second year | | 20.00 |
| Third year: | | |
| Same expenses as for the second year | | 20.00 |
| Fourth year: | | |
| Same expenses as for the second year | | 20.00 |
| Fifth year: | | |
| 1. Ring weeding (4 times) | 12 | 12.00 |
| 2. Trimming the temporary and permanent shade trees | 8 | 8.00 |
| 3. Pruning the lanzon trees | 10 | 10.00 |
| Total expenses for the fifth year | | 30.00 |

The average annual maintenance expenses for pruning of the plants, trimming the shade trees, cultivation, treatment of diseases, and mulching is estimated to be ₱25 to ₱30 from the 6th to the 12th year.

The total expenses for planting and bringing into bearing one hectare of lanzon plantation is ₱457.40.

The expenses in the maintenance of the lanzon plantation up to the bearing stage may be reduced by planting bananas which should be thinned out as fast as they come to interfere with the development of the lanzon plants.

If grafted and marcotted plants are to be used for planting the cost of planting materials will vary according to the cost of grafted and marcotted plants. Grafted plants cost ₱1 each, and marcotted plants cost about ₱5 each. The plantation is expected to bear much earlier, however.

(*b*) *Cost of production per hectare at full bearing—204 trees*

| Items of operation | Man | Approximate cost |
|---|---|---|
| | *Day* | *Pesos* |
| 1. Maintenance expenses for pruning, treatment of diseases and general care | 35 | 35.00 |
| 2. Interest on value of land (6% of ₱500.00) | | 30.00 |
| 3. Land tax | ---- | 4.38 |
| 4. Picking 200 "kaings" of lanzon fruits | 20 | 20.00 |
| 5. Collecting the fruits | 5 | 5.00 |
| 6. Putting the fruits in "kaings" | 2 | 2.00 |
| 7. Cost of "kaings" (200) | | 100.00 |
| Total expenses | | 196.38 |
| Value of 200 "kaings" of lanzon at ₱5 per "kaing" | | 1.000.00 |
| Net profit | | 803.62 |

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## ILLUSTRATIONS

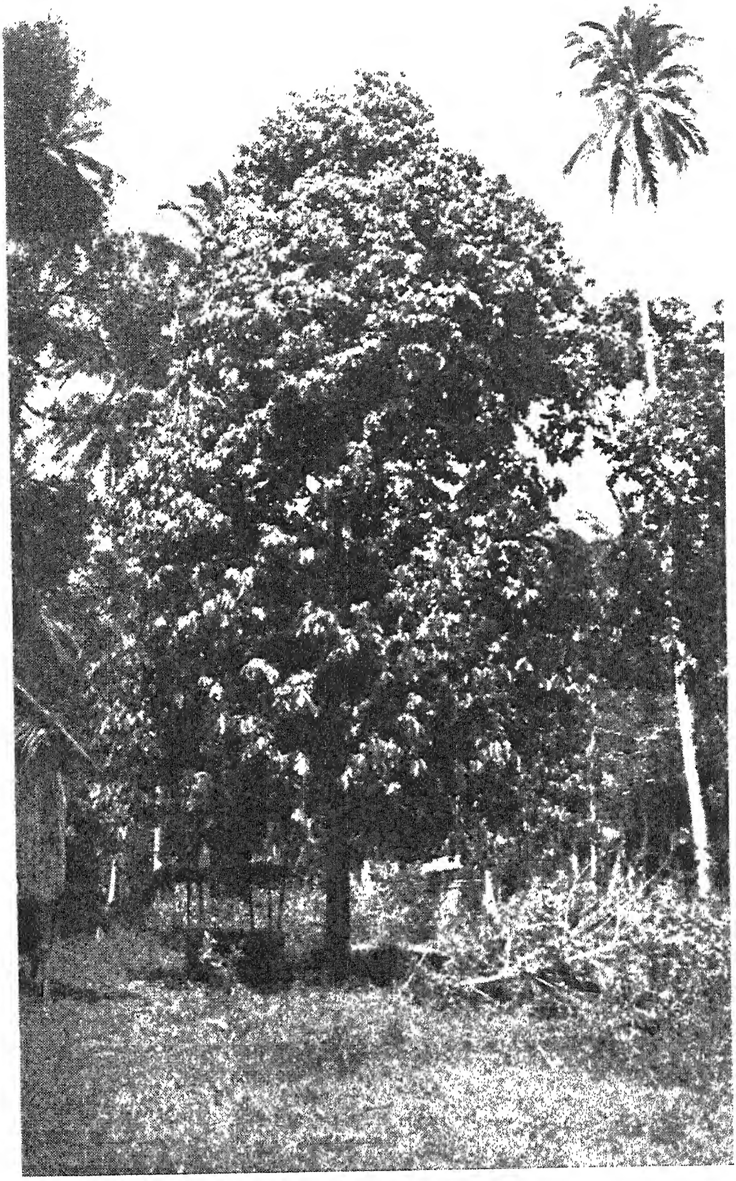

PLATE 1.

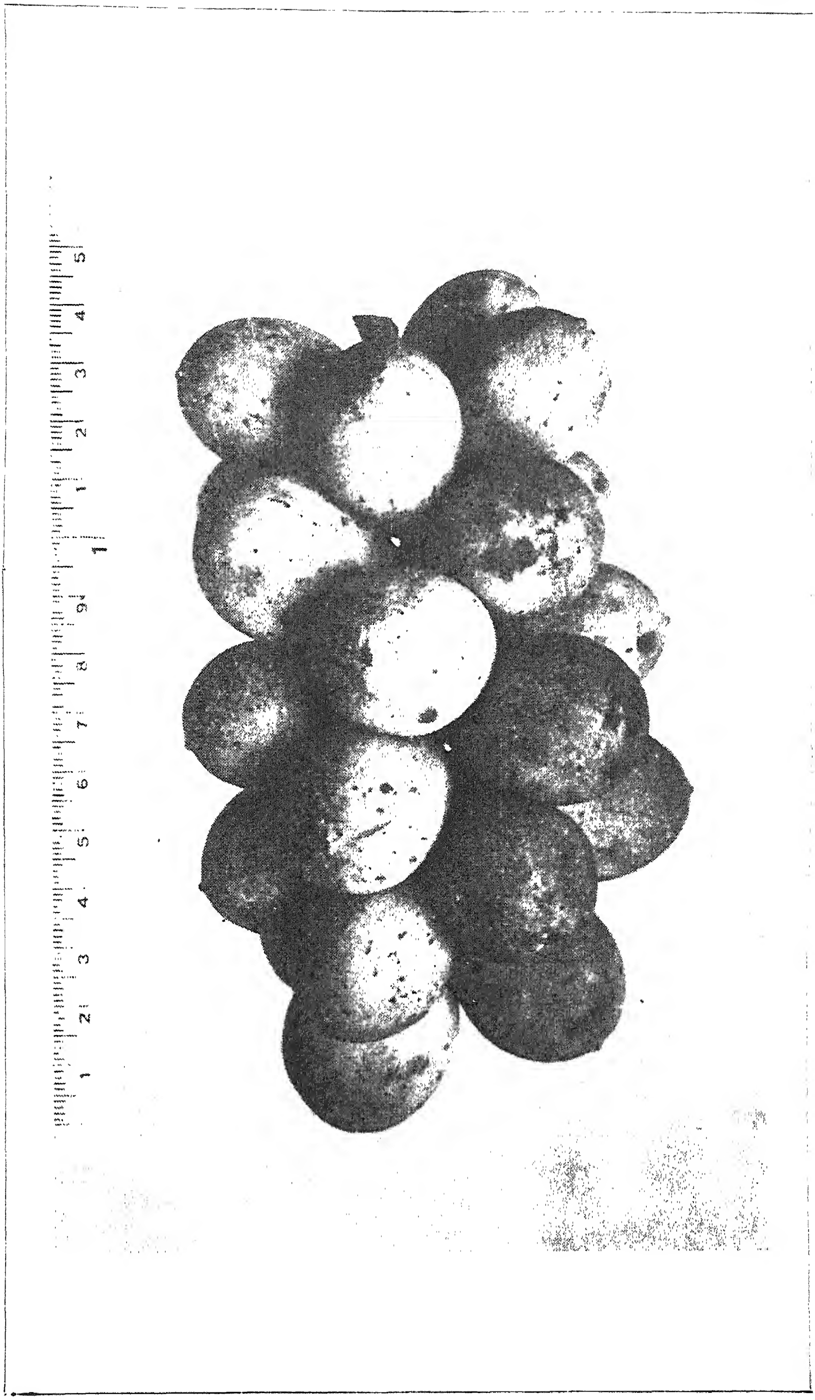

PLATE 2.

# THE CULTURE OF DERRIS

(Farmers' Circular 7—Revised)

By Juan M. Ejercito

*Assistant Agronomist*

Derris is widely distributed in the Philippines. Its use as poison for fish has been well known to the inhabitants of the Islands as well as those of the Malayan Peninsula and the East Indies, probably since prehistoric times.

Not very long ago, scientists discovered the efficient use of *Derris* roots against many kinds of insects injurious to both plants and animals. Being non-poisonous to men but very effective against insects, insecticide preparations from *Derris* roots are now preferred to calcium arsenate which has heretofore been used extensively for exterminating plant pests. At no time in the history of scientific agriculture is the demand for and the use of *Derris* greater and more extensive than now.

Insecticides worth many millions of pesos are consumed annually in the United States, Japan, and other countries. The entire crop loss caused by injurious insects in the United States alone is conservatively estimated at 4,000,000,000 pesos annually. And that country yearly consumes about 14,000,000,000 kilos of calcium and lead arsenate, and 5,000,000,000 kilos of pyrethrum valued at ₱5,325,000,000, which insecticides can be substituted by *Derris* root insecticide. The United States then, besides Japan and Europe, is one of the big markets for *Derris*. Starting in 1931, the United States imported *Derris* roots to the amount of 2,049 kilos valued at ₱940, and in 1934, this importation rose up to 203,503 kilos valued at ₱139,674. Various inquiries from different chemical laboratories in the United States have been received by the Bureau of Plant Industry regarding the possibility of obtaining *Derris* roots from the Philippines. The extensive cultivation of this plant here will undoubtedly be another source of income for the farmers.

As an insecticide, *Derris* has been found efficient, both as a stomach and as a contact poison and sometimes acts as a repel-

lant to many cold-blooded animals. It is applied either in solution or powder form. *Derris* powder applied as dust is efficient against dog fleas, cattle teak, bed bugs, chicken lice, house flies, white ants, some species of aphids, and certain vegetable pests. As spray, it is efficient against the larvæ of sawflies, imagoes and larvæ of leaf beetles, plant lice, cabbage worms, etc. *Derris* root compares favorably with any inorganic insecticide, since its application even to the youngest leaves and seedlings and on the roots of plants does not inflict any apparent damage thereon. There are many trade preparations of *Derris* now on the market, such as "Polvo" (a powder), "Kotakila" (powder and soap), "Derrisine" (a liquid), *Derris* ether extract, Derispray and Rotenone (90 per cent chemically pure).

Besides its value as a source of insecticides, *Derris,* being a leguminous plant, is capable of enriching the soil and, for this reason, it is worth trying as a cover crop. Most *Derris* species being creepers, form a close cover on the ground which may also serve as a remedy against soil erosion.

## VARIETIES

There are 15 distinct identified species in the Islands that grow wild by the sides of creeks, rivers, and lakes, and in the forests. But only one or two have shown promise and are being brought into cultivation on a commercial scale, *Derris elliptica* and *D. sp.*, sometimes called by the new name of *D. tubli.* Their analysis shows from nil to about 10 per cent rotenone content, although 4 to 5 per cent is the average. These varieties are called under various names in different regions, such as "Tuble" in Batangas, Laguna, Cavite, Tayabas, and sometimes in northern Bicol; "Polipog" in Cebu, Bohol, Negros, southern Leyte, and northern Surigao; "Pamalanak" in northern Leyte and in Samar; "Labnec" in Cuyo Islands; "Balval" in Calamian group; "Tubali" in Manobo regions; "Lapak" in southern Bicol; "Tuba" in Panay Island; "Tua" in Cotabato; "Baot" in La Union; and "Kabutot" in Bontoc. These varieties have a prostrate habit, forming a close cover, with the stems rooting at the nodes if allowed to grow without any trellise. The number of leaflets varies from 7, 9, 11, 13 or 15 and are very variable in size and shape, but usually obovate or obovate oblong, the lower one or two pairs reduced in size and broader in proportion than the others.

### IMPORTANT CONSIDERATIONS

As the value of *Derris* roots is based on the rotenone content and on the total ether extract, it is most important therefore, that prospective planters plant only the high yielding variety.

The rotenone content has been found to differ largely in different species of *Derris*, and analysis of roots of the same species and age grown in different localities in the same country may give different results. The optimum age in which to harvest so that the maximum rotenone content may be obtained may also differ in different regions. It is, therefore, very necessary that to obtain full information on these points, a fairly intensive study in the district in which any species is to be cultivated be made first. Equally important is the conscientious selection of the right planting materials. This can be determined by first analyzing the roots. If 4 or higher per cent of rotenone is obtained, stem cuttings from said plant should be immediately multiplied for commercial propagation.

### PROPAGATION

*Derris* is propagated from seeds and by cuttings. But commercially it is readily grown by cuttings since it can be easily rooted. The cuttings are mature stem or vine with 2 to 4 nodes each and about 30 centimeters long. They are closely planted in the nursery beds. Any damp ravine adjoining the proposed field is the best site for a nursery. A layer of cogon or grass is preferably laid on the bed to keep the cuttings fresh and the soil moist. In about 3 weeks, the majority will sprout and in 2 to 3 weeks more, they can be transplanted in the field. Experience has shown that the cuttings may also be preserved in moist sphagnum moss for 3 weeks before planting direct in the field, after which time some roots come out. In another instance it was also observed that loosely bundled cuttings with the base stuck in the mud under shade produce roots in about 3 weeks. It has been generally observed that if the cuttings are planted direct in the field without the practise of any of said treatments, many die and in which case they should be replaced as early as possible by fresh cuttings so as to have an even and solid stand.

The cuttings are planted in a slanting position at an angle of about 45° with the surface of the ground, and with about $\frac{2}{3}$

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The cuttings are planted in a slanting position at an angle of about 45° with the surface of the ground, and with about $\frac{2}{3}$

of the length below the surface. They are planted at a distance of 1 meter, giving 10,000 plants per hectare. A closer spacing of 90 centimeters may be set in poor soil, giving 12,345 plants to the hectare. The field should be prepared similar to those for corn, peanut, etc. In Malaya, the cuttings are planted in big ridges of about ½ meter high with the aim of rendering the harvesting easy. On newly opened land where there are considerable timber and stumps, it is sufficient to make good sized holes in which to plant the cuttings.

*Derris* should be planted in a light soil of a sandy nature. Heavy clay soils are not recommended, owing to the difficulty in harvesting the roots under such conditions. The land may be flat or gently undulating.

The best time to plant is at the start of the rainy season. Plowing between the rows during the early stage of the plants and occasional hand weeding in the rows constitute the care that should be given the plants. In their later stage, the plants almost cover the ground and only few weeds are able to survive. It has been observed, however, that derris plants grow profusely under partial shade or under humid conditions—places similar to their natural habitat.

*Derris* may be cultivated between rows of other crops, such as young coconut, young abacá, kapok, rubber, citrus, etc.

## HARVESTING AND PREPARATION FOR THE MARKET

As the toxicity of *Derris* roots varies according to their age, it is very essential therefore to know the right stage of maturity. It has been found by experiments that, considering both the yield of the root and the toxicity, the optimum age to harvest is generally 2 years after planting, although some varieties may yield from 5 per cent and higher of rotenone at one year of age.

At harvesting time, the stems are cut and drawn to one side; they do not show any toxic value. The entire roots are then lifted or dug up, cleaned of soil and tied into bundles. The smaller roots, those which should not greatly exceed the size of a lead pencil, are separated from the big ones as they contain more rotenone.

The roots are thoroughly sun-dried from 1 to 2 weeks, depending upon the weather conditions. Where *Derris* is produced in a big scale, a special flue-heated drying chamber almost similar to that used in drying copra is employed. With this method the roots are first chopped into pieces of about 10 cen-

timeters long and then dried at a temperature of about 70° C. in 3 to 4 days. Immediately after drying, the roots should be baled, otherwise they are liable to attacks of boring insects. The bale measures approximately 1 × 0.75 × 0.70 meter and weighs about 100 kilos.

To minimize freight charges owing to the bulkiness of the product, the roots may be cut into finer pieces and packed. In other forms, *Derris* is marketed as ether extract, crude rotenone crystals, powder, etc.

The yield of air-dried roots is approximately 45 per cent of the weight of fresh ones. The moisture content of the air-dried root is about 10 per cent. Under favorable conditions the yield per hectare at 2 years of age ranges from 1,000 to 1,500 kilos of dry roots. It was reported that in Cebu from 3,000 to 5,000 kilos of fresh roots equivalent to 1,350 to 2,250 kilos of dry roots may be obtained per hectare at the age of from 2 to 2½ years.

## TRADE AND MARKET

### IMPORTATIONS INTO THE UNITED STATES

| | | |
|---|---|---|
| 1931 | 4,508 pounds.... | $407 |
| 1932 | 38,337 pounds.... | 6,951 |
| 1933 | 575,785 pounds.... | 52,287 (1) |
| 1934 | 447,707 pounds.... | 69,837 (2) |

(1) (All from British Malaya except 337 pounds at $40 from the Philippines.)

(2) (In the first 9 months.)

### FOREIGN PROSPECTIVE BUYERS

McCormick and Co., 400 Light St., Baltimore, Maryland
William Cooper & Nephews, Cooper Bldg., 1909–25 Clinton Ave., Chicago, Ill.
McLaughlin Gormley King Co., Minneapolis, Minnesota
J. L. Hopkins, 135 Wm. St., New York City
S. B. Penick and Co., 132 Nassau St., New York City
John Powell and Co., 114 East 32nd St., New York City
E. C. England & Derris, Inc., 79 Wall Street, New York City
Peek and Velsor, 100 Gold St., New York City
Richard D. Heins, 126 Fulton Street, New York City
Frank B. Ross Company, Inc., 79 Wall Street, New York City
R. J. Prentiss & Co., 100 Gold Street, New York City
Robert F. Joyce, 125 Church Street, New York City
W. R. Grace and Company, P. O. Box 286, City Hall Station, New York City
Var-Lac-Oil Company, 116 Broad Street, New York City
Geo. Uhe, Inc., 102 Maiden Lane, New York City

DOUGHERTY MANUFACTURING CO., 1 Wilkins Avenue, Jersey City, New Jersey
HACKLEY HARRISON, LTD., 23 Harp Lane, London, E. C. 3
JOSEPH FLACK & SONS, Ltd., 64 Mark Lane, London, E. C. 3
A. TOELEY & COMPANY, Ltd., 30 Mincing Lane, London, E. C. 3
J. H. Z. STALLMAN, 29 Mincing Lane, London, E. C. 3
H. FRISCHMANN, 27 MINCING LANE, London, E. C. 3
THOMAS SWAN, 14th St., Marry Avenue, London
MITSUI BUSSAN KAISHA, 3 Kaigan-Dori, Kobe, Japan

## LOCAL BUYERS

*(If there is sufficient supply)*

WARNER, BARNES & CO., INC., Perez Samanillo Bldg., Escolta, Manila
REMIGIO RAMIREZ, Tagbilaran, Bohol
MITSUI BUSSAN KAISHA, National City Bank Bldg., Manila
GETZ BROTHERS, 5th Floor, De los Reyes Bldg., Manila
F. E. ZUELLIG, INC., 55–63 Rosario, Manila
SEBASTIAN M. GALANG, 1834 Felix Huertas, Manila
F. D. THOMPSON, 1158 Dakota, Manila
G. GONZALES, 322 Misericordia, Manila

## PRICES

The current prices of *Derris* roots, f. o. b. New York City, range from 10 to 25 cents gold a pound for roots containing 1 to 5 per cent rotenone. Mr. Ramirez offers to buy from ₱0.07 to ₱0.14 for a pound of fresh *Derris* root and from ₱0.15 to ₱0.20 per pound of dry roots.

The local buyers may be consulted further for particulars with regards to conditions of purchase and price.

## PROSPECTS

The United States' demand is far from being supplied; the past imports for botanical insecticides, mostly pyrethrum, amounted to about $2,500,000 a year, and more, the United States Federal Government is favoring the use of these botanical insecticides as against arsenates which are cumulative poisons.

# ILLUSTRATIONS

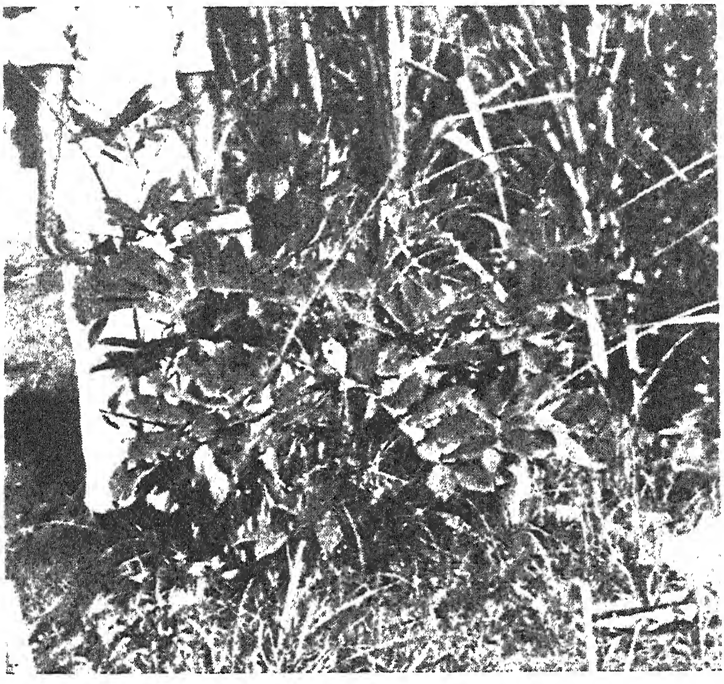

PLATE 1.

PLATE 2.

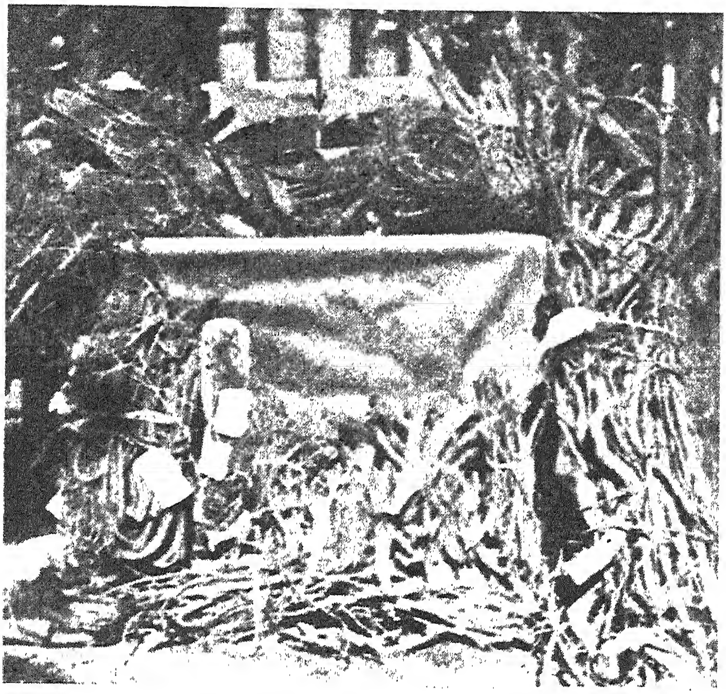

PLATE 3.

# PEANUT CULTURE

(Farmers' Circular 9)

By Juan M. Ejercito
*Assistant Agronomist*

THREE PLATES

Peanut and peanut oil constitute an important import item of the Philippines. For the last twelve years (1921–1933) our total importation amounted to ₱9,425,015 or a yearly average of ₱785,418. To minimize or curtail this importation, it is very essential to know the qualities of peanut that the market demands. At present, the increasing demand, perhaps for confectioneries is for the following classes: (1) 28 kernels to the ounce; (2) 30 kernels to the ounce; and (3) 32 kernels to the ounce. This requirement may easily be met by planting the high yielding big-kerneled varieties.

After the local demand is satisfied, the surplus production can be exported abroad. The United States is a big importer of peanut. For the last five years (1930 to 1934) her total import in nut and oil was valued at ₱4,903,660.

## VARIETIES

At present there are many existing varieties of peanut cultivated in different parts of the Philippines. Many are identical to each other although they differ in their local names in different places. Others are really distinct varieties.

According to their manner of growth, the peanuts are classified into two types: (1) The bunchy type which grows erect and forms pods in clusters around the base of the plant, and (2) The runner type which has a creeping habit and forms pods along the lateral stems that touch the ground. To the former type belongs the Spanish, Cagayan No. 1, and Cagayan No. 2, Vigan Lupog, San Jose No. 3, Biit, and Tirik varieties; and to the latter, the Virginia Jumbo and Tai-tau varieties.

In the market, peanuts are again classified into big-sized nuts and small-sized nuts. The big-sized nuts are those which number 28 nuts, 30 nuts, and 32 nuts to the ounce. They are gen-

rus, and 4 per cent potash, applied at the rate of 300 to 500 kilos per hectare. Lime improves the quality of the peanut. The pods are usually better filled and the shells are whiter.

The yield may also be increased by soil inoculation. This was the result of an experiment conducted by the Institute for Agricultural Teachers, at Langersari, Bandoeng, Java, in which an untreated plot produced only 448 kilos while the plot inoculated with 8 hundred weights of bacteria-bearing soil per acre or about 894 kilos per hectare, produced about 558 kilos per hectare or an increase of 110 kilos over the untreated plot.

## SPECIAL CULTURAL PRACTICES

In the United States, after the final cultivation a light roller is run over the plants to flatten the stems upon the ground. This operation enables the pegs bearing the would-be-pods to reach the soil and cause the maximum number of pods to mature at almost the same time. This practice is done only with the runner varieties which are not injured by the roller. With the bunchy type, it is neither necessary nor advisable.

## HARVESTING

Maturity is indicated by a light yellowing of the foliage (not due to disease or pest), and the darkening of the veins inside the shell. The usual maturing period is from 105 to 125 days for most of the bunchy type varieties and from 165 to 185 days for most of the runner varieties.

Harvest when the soil is reasonably dry. One objection against the coincidence of maturity with the rainy days is the difficulty of harvesting when the soil is too wet. Pending better weather, the pods get over-mature and may rot or germinate. The drying of the newly harvested pods is difficult.

## CURING

Curing is not generally practiced in the Philippines. The usual practice is to pick the pods immediately after the harvest, clean them of soil, and dry them well in the sun. This results in the production of many shriveled kernels. Through proper curing, as described hereunder, this defect will be overcome.

After the plants are dug up, they are shaken to remove as much as possible the adhering soil particles on the pods, and spread on the ground for exposure to the sun to wilt the vines slightly. Then they are placed in small stacks around poles to

which two or more cross pieces have been nailed or tied at right angles to each other, about 30 centimeters from the ground.

The poles are about 2 meters long and 2½ centimeters in diameter at the base and sharpened at both ends. The cross pieces are about 40 centimeters long. Bamboo or wood may be used for this purpose.

The vines are stacked around the poles with the pods adjacent to the poles. The completed stack should be about 1½ meters high. The top is capped with some weeds or straw to protect the stacked peanuts from the rain. Normal curing lasts from 4 to 6 weeks.

### PICKING AND SHELLING

Pick the pods during bright and hot weather when the vines are brittle and picking easier. During cool weather the vines are rather tough and picking is difficult. Separate the marketable pods from the unmarketable ones while picking. Properly picked pods should be free from stems, dried leaves, and other foreign materials.

The native and usual way of shelling is to press the pods between the fingers, taking care of course, not to press so hard as to split the kernels. Plenty of split kernels lower the quality of the product in the market. The hand method of shelling is quite slow, laborious, and expensive when the crop is handled on a commercial scale. The work may be facilitated and the expenses minimized by the use of a shelling machine.

### YIELD

Like any other crop, the yield of peanut varies with the variety, season, type of soil, culture, diseases, and pests, etc. At the Lamao Horticultural Station of the Bureau of Plant Industry, it was found out from the four years' test that the three highest yielding varieties were San Jose No. 3, 12.69 cavans of kernel; Spanish, 12.55 cavans; and Tennessee Red, 11.99 cavans. At the College of Agriculture, Los Baños, Laguna, it was reported that Valencia gave an average production per hectare of 26.4 cavans pod or about 16.3 cavans kernel; Spanish Red, 19.4 cavans pod or 14.74 cavans kernels; Vigan Lupog, 25 cavans pod or 18.25 cavans kernel; and Kinorales, 23.1 cavans pod or 17.78 cavans kernel. In the entire Philippine Islands, the average yield in 1935 was 547 kilos per hectare or about 12 cavans of shelled nuts.

One of the principal ways of curtailing the importation of peanuts in the Philippines is to produce by selection or hybridization varieties which are high yielding, big-seeded, early maturing, and disease resistant. The Bureau of Plant Industry is now working along these lines.

The final profit depends very much on the price of peanut. Assuming that the price is ₱7 a cavan, which is very conservative, the value of the harvest per hectare would be ₱75. Upon the ability of the farmer to reduce the cost of production depends his profit to no small extent.

### COST OF PRODUCTION

The cost of raising a hectare of peanut varies, depending upon many factors, such as: season, soil type, variety, culture, labor conditions existing in the locality, etc. From land preparation to preparation of the crops for the market, the Bureau of Plant Industry has found that the total expenses amount to ₱87.41 per hectare. The College of Agriculture, Los Baños, Laguna, has reported that it costs ₱86.57 in the wet season and ₱77.22 in the dry season to produce a hectare of peanut.[1] The above costs were based on ₱1.00 per man-day and ₱0.80 per animal-day. In localities where daily labor is from ₱0.40 to ₱0.60, the cost of production would be greatly minimized.

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[1] College of Agriculture Bi-weekly Bulletin, Aug. 15, 1933.

## ILLUSTRATIONS

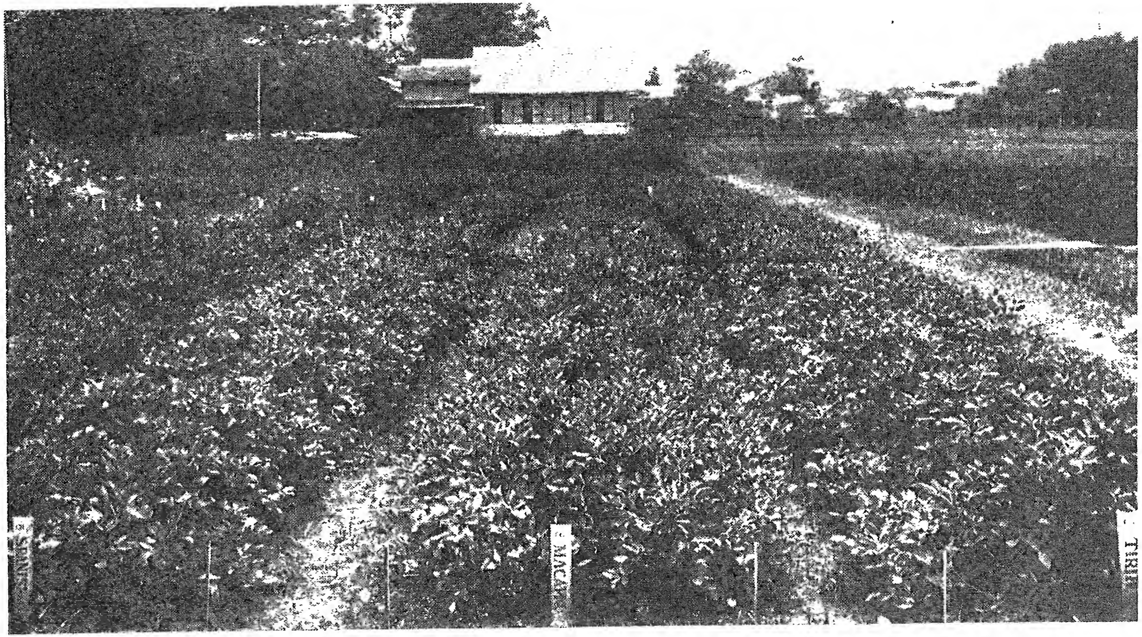

PLATE 1.

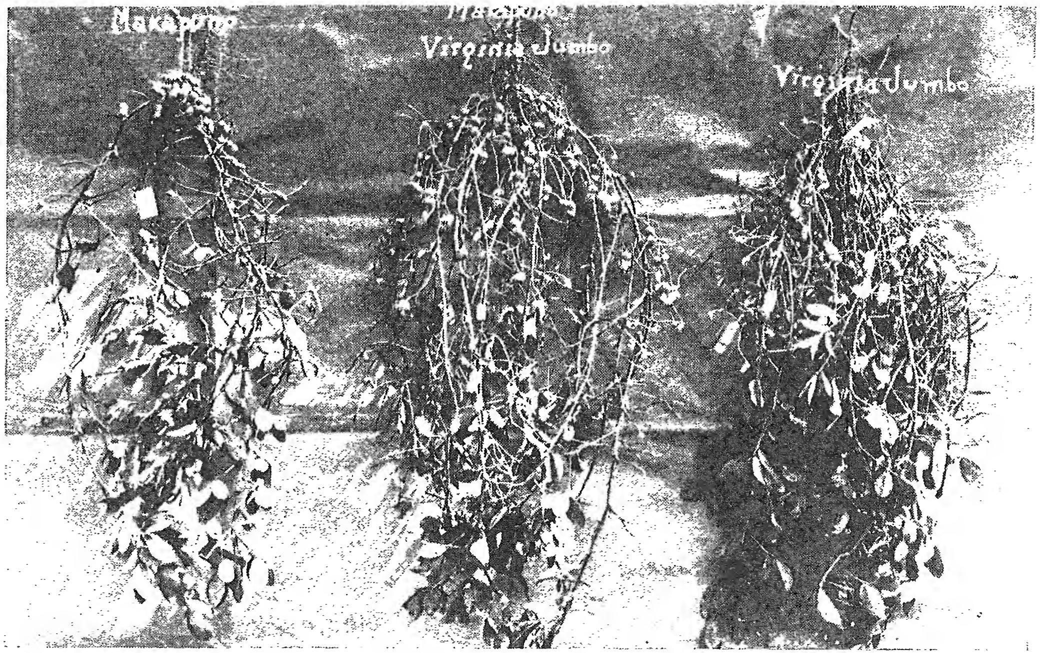


PLATE 2.

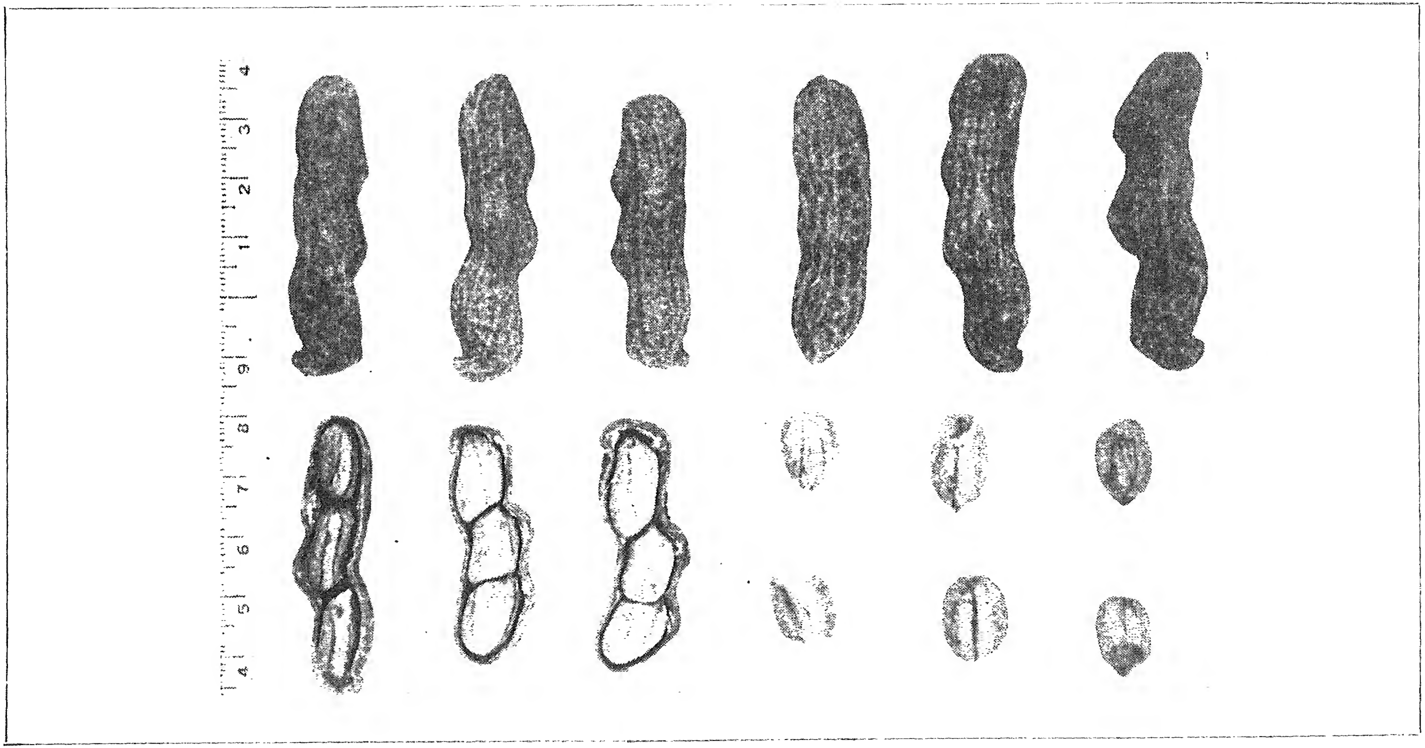


PLATE 3.

# THE GENERAL PRACTICE OF LOWLAND RICE FARMING IN THE PHILIPPINES

(Farmers' Circular 39)

By BASILIO R. BAUTISTA

*Assistant Agronomist*

SEVEN PLATES

Rice is the most important crop of the Philippines. It is the main article of food of the people.

The average production of rough rice in the Philippines, according to statistics, was 26.9 cavans per hectare in 1933–34. In India, under the irrigated areas the average production per hectare is 34 cavans; in Java, 37 cavans; in U. S. A., 44 cavans; in Japan, 76 cavans; in Italy, 98.5 cavans; and in Spain, 144 cavans. Obviously, there is much room for improvement in our rice farming to increase the yield per unit area. This paper deals with conditions of rice farming in rice districts in the Philippines with some suggestions offered for the improvement thereof.

## GROUND PREPARATION

*Seedbed.*—There are various types of seedbeds which are prepared under different methods as follows:

*Type 1.*—In Northern Luzon, chiefly in the Ilocos Provinces including Cagayan, Isabela, and the Mountain Province, the general practice is to prepare dry seedbed located on a high place with fertile soil, instead of locating them in the lowland as is done in Central Luzon.

This type is not, however, uncommon in northern parts of Nueva Ecija and Tarlac where the Ilocanos are working the lands. The method of preparing the seedbed is similar to that of the upland rice, consisting of from two to three plowings each followed by harrowing. At the first available hard rain in May or June the seeds are hand-drilled in rows to amount 25 gantas per 200 to 250 square meters to plant a hectare. On account of the thick seedage the seedlings produced are slender and apt

to form nodes at the age of over 35 days from date of sowing. On account of the uncertainty of water supply, which depends entirely on rainfall, it is oftentimes necessary to wait as much as six to eight weeks, before the rice could be transplanted. Then the seedlings are over the planting age and will give low grain yields. This method may be applied on irrigated places where the area of lowland rice field is limited. To produce stocky seedlings the area of the seedbed should be increased to 500 square meters to allow more space for their proper development.

*Type 2.*—The method employed in some of the Visayan Islands is the same as the Ilocano method, Type 1, except that the seeds are broadcasted at the rate of 25 gantas per 150 to 200 square meters. The defects of the seedlings produced are the same as in Type 1 of seedbed, which may be improved by increasing the area to 400 square meters, and covering the seeds after sowing by light plowing and harrowing. The seedlings in both cases may be planted in five to six weeks old.

*Type 3.*—In Central Luzon, the ground is generally plowed once, and harrowed twice, and in 3 to 5 days the seeds are sown. The farmers usually do not take into account the area of the seedbed necessary for sowing a given amount of seed, and this results in overseeding and consequently, weak seedlings are produced. Under normal conditions, a well prepared seedbed should have at least 15 to 16 days preparation. The first harrowing should be done 3 to 4 days after breaking or first plowing. This consists of breaking the clods and incorporating the organic matter into the mud; 7 to 8 days after first harrowing, crosswise and lengthwise harrowings follow to destroy the weeds and level the ground. Three days afterward, the third harrowing or puddling preparatory to sowing is made. Before the seeds are sown a flat board of sufficient weight is passed over the seedbed to smoothen the surface and make it convex longitudinally so as to provide a run-off for surplus water. Two or three hours later, the mud thus settled, the seeds can be sown at the rate of 25 gantas for every 333 to 400 square meters, enough to plant a hectare. In most cases the farmers do not close the gate of the seedbed after sowing which results, in the event of hard rain, in the carrying away the seeds by water. Seeds sown immediately after preparing the seed-bed would

sink deep into the mud, in which condition they are prevented to grow, or otherwise the resulting seedlings would be hard to pull up when the time for transplanting comes. After twelve hours from sowing, the surplus water should be removed by opening the gates so as to facilitate the growth of the incipient seedlings and at no time the seed bed should have standing water, for this will render the seedlings hard to pull up preparatory to transplanting. It is necessary therefore, for the seed, bed to be located in a place that can be irrigated and drained at will. Preferably rich soil should be selected. The seeds before sowing should be soaked overnight, then drained for one and a half day under shade and kept moist to hasten germination. As a general rule the seedlings of different varieties can be transplanted at the age of 5 to 6 weeks; beyond this age the seedlings will have produced nodes, one of the factors that cause low production of grains.

## LAYING OUT AND PREPARATION OF THE FIELD

Experience shows that the ability of a given paddy or paddies to retain water in much longer time depends upon the lay out of the dikes or levees. Paddies having higher grades are subject to lose water in shorter time due to natural seapage. On hill sides, the size of the paddies is determined by a fall of 20 and not more than 30 to 40 centimeters. The dikes, of course, should be thick enough to retain water. Loose soil should have bigger dikes than clay soils.

Gravelly and sandy soils after harrowing, settle immediately through the action of running water. To avoid replowing due to settling, running water should be cut off by closing the gates

The use of the proper implements gives proper impetus in the rice farming. The employment of bamboo harrow and spike-toothed board is a draw back in good farming as these implements are inefficient, both in leveling the soil and incorporating the organic matter into it. The general use of these implements in Northern Luzon and in the Visayan Islands accounts for the thick growth of weeds in the rice fields, in spite of irrigation and other good factors present. It may be noted also that unevenness of the surface of the paddies, especially under the irri-

gated areas, is the cause of uneven maturity of the crop. The right implement to be used in harrowing is the native steel harrow (suyod) which is generally employed in rice farming in Central Luzon (*see* Plate 1). The trampling or yatac method by carabaos of soil preparation preparatory to transplanting as is done in the Visayan Islands, is bad practice for the simple reason that transplanting follows immediately and not sufficient time is allowed for the decomposition of the organic matter. Under exceptional condition, such as deep wallow, where plowing and harrowing are impossible, this method may be resorted to.

The farmers in general prepare the land in a crude way, that is, in addition to one plowing, the field is harrowed one or two times preparatory to transplanting. This method does not allow the proper decomposition of organic matter. It is the general conception among rice planters that one plowing and two harrowings are enough to produce a good stand of rice crop. This may be true under exceptionally good soils but under the average soil fertility in Central Luzon and elsewhere, one plowing with three or four thorough harrowings before transplanting will be the most appropriate method of ground preparation.

In good rice farming, it is very necessary that the soil in the paddy be well "mucked," so to speak, 18 to 21 days. It is common but erroneous practice, that while harrowing, the water in the paddies are kept running or flowing with the main object of removing weed seeds present. This is detrimental to the preservation of soil fertility, and should be done only after the soil has settled down. The right procedure is to provide only sufficient amount of water to facilitate harrowing, and to close the gates while harrowing in order to prevent sheet erosion. The ground should at no time be allowed to bake. It is a common observation that no special attention is given to the proper construction or repairs of dikes. Good dikes should be at least 45 to 50 centimeters thick and 50 centimeters high on clay soils, and much thicker on loose soils to have a better control of the irrigation water.

*Type 4.*—The "dapog" seedbed method is one that would save indigent farmers. It has several advantages, namely:

(*a*) The seedlings could be planted in 9–12 days from date of soaking. Rain-fed areas where the supply of water for gen-

eral preparation is uncertain, should practice this type of seedbed for the reason that the general field is already prepared in time when there is sufficient water to start the seedbed.

(*b*) In case the planting season has far advanced due to lack of water supply or, as the case may be, the rice after planting has been destroyed by floods, or damaged by pests, replanting of the field may be desirable, and seedlings should be raised by the "dapog" method.

(*c*) The seedlings produce earlier crops, saving from 15 to 20 days in the usual maturing period.

In preparing this type of seedbed, the ground should be plowed, harrowed, and well puddled similar to that of type of seedbed No. 3. The ground thus prepared should be laid on with one layer of whole banana leaves. Torn leaves should be patched up with a piece of the leaf to prevent the roots of the seedlings to penetrate into the ground, lest the tender seedlings be spoiled in pulling up preparatory to transplanting. The leaves thus laid with sides overlapping each other to permit no space between them with prominent midribs underneath, are pressed lightly downward so as to allow the accumulation of mud to a depth that would permit the growth of germinating seeds. The seeds previously soaked and drained for 36 hours can then be sown. The "dapog" seedbed requires an area of 30 to 45 square meters in the form of small convenient-sized lots to hold 25 to 30 gantas of seeds in all, which are sufficient to plant a hectare allowing for the seeds that died out due to overcrowding. In the absence of rain or irrigation water, the seedbed should be watered, and no standing water be allowed to prevent scalding due to sun heat. In 9 to 12 days, the seedlings should be transplanted, otherwise the seedlings will have formed nodes or grow spindling. The seedlings under this type of seedbed have the roots interlaced in mat-formation, which should be divided into convenient sizes to facilitate handling by the planters. Planting is generally much thicker than in the case of other seedlings, and a hill may contain from 6 to 8 seedlings.

"Dapog" seedbed may be constructed under the shades of banana trees, coconuts, etc. The media that could be used, to be placed on top of the banana leaves, are either rice-hull or rice-chaff of the same variety to be planted, fine-chopped rice-straw or sand. If other medium than sand is used, it should

have a slight dressing of either sand or fine soil, so as to fill the inter spaces. The seedbed should be sprinkled with water before sowing the seeds and watered thereafter, morning and afternoon, depending upon the weather condition. After sowing, the seeds should be covered with a thin layer of fine sand or soil to prevent their rapid drying. These matters should not be overlooked.

## CARE OF THE CROP

After transplanting, the rice field should be taken care of. The gates should be kept closed; the field should not be exposed to surface erosion, and weeds be removed as soon as developed. (Plate 2.) It should be known that weeds crowd out rice plants and inhabit tillering. The most approved method in the care of the crop after planting is to close the gates to about 10 centimeters high after transplanting to avoid any possible loss of soil fertility. From 7 to 10 days after, irrigation water can be applied to a depth of 8 to 10 centimeters, gradually increasing it to 18 to 20 centimeters as the plants increase in height, and depth of submergence maintained during the growing period to prevent the growth of weeds at the time of tillering. (*See* Plate 3.) Productive tillers are usually produced within three months after transplanting so that after that period the submergence may be lowered gradually to 10 down to 8 centimeters deep. Occasional draining should be practiced to prevent water stagnation and to allow aëration, but irrigation water should be applied before the soil begins to crack, otherwise the plant growth will be checked. Weeding, if necessary, should be done, especially during the growing period of rice by pulling up the rootstocks instead of the general practice in some of the southern islands of merely topping off the weeds with the use of bolo or scythe, thus leaving the rootstocks to grow again and feed on the soil fertility, and depriving the rice plants of some food and sunlight. In case of ranky growth that would cause lodging the irrigation water may be withheld until all the leaves have shown stiffness, for the leaves of lodging rice are dark green, soft, and bending downward.

The care of the transplanted "dapog" seedling is very important, and that if not properly attended to, it is liable to lose part or the whole of the rice crop. All the gates, after transplating should be closed to prevent washing out and the paddies kept in saturation only from three to four weeks after transplanting

to allow the young plants to develop. Draining should be made to prevent the drowning and scalding of the tender plants during hot days. When the plants have attained the height of about 20 to 25 centimeters, the same care as the ordinary rice crop can be given. Irrigation water should be removed at dough stage to hasten maturity, and harden the soil before harvest time.

### VARIETY SELECTION

It has been the practice from time immemorial that the seeds for planting are obtained from the farm's granary just before sowing time. The seeds thus obtained consist of different mechanical mixtures and broken grains due to the use of modern threshing machines. Mixed seeds cause non-uniformity of maturity and type of grains, hence affect adversely both the quantity of production, and the quality of the product. The seeds should therefore be secured at maturity just before harvest time to insure better germination, purity of the seeds, yields, and quality. As a general rule, landlords determine the varieties to plant and in most cases, the use of the right variety is overlooked.

In sugar cane lands or the like converted into rice fields, where the nature of the soil is porous and where water does not stay long, and in places that are hard to irrigate, early varieties, such as Apostol, Guinangang Str. 1, and Inachupal I are much preferred. Other early varieties may do well, but none so far have outyielded the varieties just mentioned. In places that are easy to irrigate, retentive of water, and easy to drain, the medium late varieties are best adapted, such as Macan Tago, Macan Santa Rosa, Macan Aga, Macan China, Manticanon, Mancasar Str. 3, Kho Bai Sri, and several others. In places that are fertile, easy to irrigate, retentive of water, and easy to drain, Khao Bai Sri, Manticanon, Macan Lamio, Inadhica, Elon-elon and Ramai are best adapted. In places that are water logged, where other varieties do not do well on account of their weak straw, Elon-elon and Ramai will do well.

It is of interest to note also that in some places strong northeasterly winds occur from about the middle of November up to March. In regions like these, and where soil conditions are normal, usually the pollination of the late varieties is much affected, hence more chaffy than full grains are produced. Under this condition, both the early and the medium late groups will do well.

The following is the table showing the average yield of commercial rice varieties:

| Variety names | Number of days to maturity | Yield per hectare | Special qualities |
|---|---|---|---|
| Guinangang Str. 1 | 140 | 61 | Can be grown also as palagad and it matures in 157 days. |
| Apostol (called in Bulacan as Señora II) | 144 | 66 | Dual purpose, may be used as upland and lowland rice, superior grade and good eating quality. |
| Inachupal | 169 | 54 | Considered as ordinary rice. |
| Khao Bai Sri | 183 | 59 | Much in demand in the market for its good milling and eating quality. |
| Macan Tago | 180 | 51.5 | Considered as ordinary rice. |
| Mancasar (known in Bulacan as M. San Isidro) | 178 | 62 | Do. |
| Macan Santa Rosa | 180 | 68 | Do. |
| Manticanon | 184 | 68 | Do. |
| Macan Lamio | 184 | 60.4 | Considered as ordinary rice with good eating quality. |
| Elon-elon | 194 | 65 | The variety that is exported to the U. S. much in demand on account of its superior milling and good eating qualities. |
| Inadhica | 194 | 61 | Weak straw, soft rice with good eating quality. |
| Bangbang | 195 | 67 | Fair milling and eating quality. |
| Ramai | 196 | 76 | Good milling quality and poor eating quality. |

## SEED SELECTION

Under normal condition, like begets like so that seeds taken from the granary consisting of different mechanical mixtures in addition to poor yield characters, because of the existing varied population, have no end in the improvement of the variety both in yield and quality and also adaptability to a certain extent. A standing crop of rice may be good at a glance, but upon close observation it may be found that the heading or maturity is not uniform, which is one of the factors responsible for low production.

There are various methods of improving rice varieties, but one which is most practicable, and which is within the means of rice farmers, will be discussed in this paper as follows:

*Mass selection.*—At maturity, before harvesting, select representative lots where selection of the seeds will be conducted. Select only the best plants standing erect and having the most number of bearing culms with uniform height, uniform maturity, with full grains free from sterility, and diseases. Avoid selecting plants that are favored by outside influences such as drop-

pings of animals and flow of natural fertility from the surroundings, also border plants having the advantage of light are to be avoided. About a ganta of the seeds will be sufficient, the more the better, to start with. The seeds thus selected should be dried, cleaned, and kept until the planting season. These seeds should be sown in a special seedbed, and the resulting seedlings planted in separate paddies using only one seedling per hill with spacing of about 20 x 20 to 25 x 25 centimeters depending upon the fertility of the soil. Medium rich soil is much preferred as test plot. Condition being normal, and only one seedling planted per hill, good plants as described previously manifest the desirable characters that are essential in the improvement of a given variety. From this crop, the selection of seeds for improvement should be made for continuous selection until the fourth generation is reached. Although the product of this method of seed selection consists of mixed strains, still they are superior to the original stocks. The good plants selected from the fourth generation should be used for further selection until the maximum production is reached. The remnants from the fourth generation up to succeeding generations can be propagated for general plantings, using the seeds of the ensuing generations for the following planting season. To be more explicit, a farmer should provide himself with a test plot of convenient size where to do continuous seed selection work and a propagation plot to propagate the selected seeds enough to give him material to plant his whole rice field from year to year until the desired results are obtained.

After the rice harvest the field is bare-fallowed, so that there is a constant drain of soil fertility, from year to year, which is never replaced and which explains why most of our rice soils nowadays are worn out. According to Bulletin No. 37, Rice in the Philippines, by Jose S. Camus, p. 40, that an average production of 40 cavans or 1,744 kilos of rough rice (palay) to the hectare, the following amounts of soil fertility are removed:

| | |
|---|---|
| Nitrogen | 20.64 kilos |
| Phosphoric acid | 10.32 kilos |
| Potash | 4.54 kilos |

If an equal amount of straw is removed, the following quantities of plant food elements are lost:

| | |
|---|---|
| Nitrogen | 11.00 kilos |
| Phosphoric acid | 2.44 kilos |
| Potash | 28.03 kilos |

Of course, straw is left in the soil and part of it is eaten by animals and the worst disposal of it which should be condemned is the wholesale burning after rice harvest, for what is being recovered only is the potash which is present generally in sufficient quantity, whereas the nitrogen and the phosphoric acid are lost completely. Burning rice straw may be done only within certain limitations. It is permissible where the field has been seriously infested with insect pests or else infected by a disease.

The loss of nitrogen and phosphoric acid can be replaced by the use of green manure which is done by broadcasting legumes such as mongo, tapilan, and others at the rate of 15 to 25 gantas per hectare; and plowing the crop under while in full bloom or just before the pods are formed.

## FLOATING RICE

There are three varieties of floating rice that are under trial by the Bureau of Plant Industry. These varieties are the Kra-Suey, Seniñora I, and Seniñora II. The tests made show that Kra-Suey is promising. The variety has shown adaptability in low places that are subject to deep submergence. Areas that are affected by strong flood current are not suitable to this variety for the crop will be carried away by the stream. It thrives best on where the rise of water is gradual and can stand deep water as long as the youngest leaves are above the water. Series of tests had been made in Candaba, Pampanga, and the average production per hectare so far found was 25 cavans to the hectare, and in swampy places in Pangasinan an average of 20 cavans was secured when previously little or no crop at all from those places were realized. The plants grew as high as 3 meters or more.

The planting is similar to that of an ordinary upland rice after the land has been prepared in the usual way. The seeds are broadcasted at the rate of 25 to 30 gantas per hectare, followed by light plowing with harrowing thereafter to cover the seeds. Planting is usually done in the latter part of April or in May when there is sufficient moisture in the soil to keep them growing until flood time.

## PALAGAD RICE

The planting of palagad rice generally begins from November to February. The planting is done either by direct broadcasting or transplanting method. For best results, transplanting is the

best method that should be followed. The seedlings may be produced in accordance with seedbed type No. 3 or type No. 4 described previously in this paper, but for best results as obtained in the Province of Laguna, where extensive palagad rice planting is made, seedlings produced by "dapog" seed bed, type No. 4, should be used.

In the following table is shown the varieties of rice that are recommended for palagad purposes:

| Variety name | Number of days to maturity | Yield per hectare (cavans) | Quality of rice |
|---|---|---|---|
| Guinangang | 152 | 50.0 | Ordinary. |
| Sipot known as Binuhangin in Siniloan, Laguna | 144 | 45.0 | Ordinary. |
| Kinawayan | 144 | 45.0 | Do. |
| Sinadyaya | 135 | 34.0 | Do. |
| Dinagat | 137 | 32.0 | Do. |
| Inintiw | 135 | 32.0 | Do. |
| Mangasa (Tanza) | 137 | 32.0 | Do. |
| Pinursigue | 135 | 30.0 | Do. |
| Balibod | 137 | 30.0 | Do. |
| Baranay | 139 | 29.0 | Do. |
| Binicol | 135 | 25.0 | Aromatic and soft. |

The Binicol variety does best by direct broadcasting at the rate of 30 gantas to the hectare, and requires shallow submergence or saturation to maturity.

## SOIL FERTILIZATION

Lands with average production of 35 to 40 cavans per hectare need to be fertilized at the rate of 150 to 200 kilos of ammonium sulphate per hectare. Other chemical fertilizers supplying from 30 to 40 kilos of nitrogen per hectare may be used. Complete fertilizer supplying 30 kilos of nitrogen, 30 kilos of phosphoric acid, and 40 kilos of potash may be good also. Sandy soil does not pay to be fertilized on account of the porous nature of the soil, however, application may be made, provided, that the place is provided with natural hard pan that will prevent the loss of the fertilizer due to sinking. Poor seedlings may be fertilized as top dressing at the rate of 60 to 80 kilos per hectare with ammonium sulphate; seedlings that are destroyed by cut worms may be treated also with the same amount of the fertilizer in order to bring them back to normal condition, fit for transplanting purposes. The application of the fertilizer in all cases should be made when the paddies are at the saturation point

only, that is, all surplus water be drained completely, and the gates closed after the application to prevent the loss due to leaching. After a week time the gates should be opened to remove the stagnant water. In the case of the planted field, the removal of the stagnant water due to the closing of the gates after the application of the fertilizer is very important also. The crop can be kept irrigated, from time to time as required.

### PESTS AND DISEASES

The most common pest attacking the rice seedlings in the seedbed is the army worms, *Spodoptera mauritia;* it can be prevented by light trapping the adult insects and collecting the masses of eggs deposited on the leaf-blades before they hatch into larvæ. While in the larval stage, flooding whenever irrigation water is available, is the most effective control. In order that flooding will be effective, the dikes should be repaired to prevent possible leaking, and should provide also a sort of a raft laid on top of the water where the larvæ will crawl for safety which could be rolled off to collect the pest. The operation should be repeated until all the worms are collected. The use of calcium arsenate and rice bran poison is also effective. The calcium arsenate is applied as dust with a fine sinamay bag or a rice gunny sack early in the morning or in the evening while the leaves are still moist. The rice bran poison is to be applied while the ground is dry. The bait is scattered on the infested fields. This will induce the larvæ to stop and eat the poison baits. Another serious pest attacking the rice plants is the stem borers. The attack is very severe in the latter part of July and in August, and part of September.

*Symptoms.*—General yellowing of the leaves with the youngest leaf drying. The young larvæ, upon examining the affected rice plants, may be found inside the stem eating the tender parts.

*Control measure.*—Plants attacked with this pest generally do not recover, so that it is necessary to pull up the plants with the root-stocks and burn them or bury deep into the mud to destroy the larvæ or pupæ in order to cut off the cycle of the pest. Light trapping with the coöperation of the neighboring planters will also be a good control measure.

Rice bug, *Leptocurisa acuta* is a serious rice pest that causes severe losses on grain yield, especially on early varieties of rice planted in a limited scale.

*Symptoms.*—The presence of insects sucking the rice grains in milk stage; panicles of rice standing erect with light straw color as though matured with empty grains.

*Control measures.*—Tall grasses harboring the pest should be cut down. A month before heading of the crop, bait such as putrifying meat should be hung on poles of convenient height along the borders and interior dikes where the pest could feed on. At sun-rise and before sun-set the insects are found on the host, and that by passing a lighted torch under the bait will destroy the pest. Other measure, such as planting rice in a bigger scale, will minimize the destruction made by the insects as well as birds.

### STEM ROT DISEASE OF RICE

The stem rot, *Sclerotium oryzea* is a serious disease found affecting the rice plant which is found common on places with stagnant water. Rice plants affected with the disease never recover. Varieties of rice with weak stems or straw are very susceptible.

*Symptoms.*—The plants look healthy, but bending and reclining downward. When the plants are pulled up, they separate easily from the rootstocks and emit putrifying odor, due to the general rottening of the stems. The disease could be transmitted by insects, animals, and water.

*Control measures.*—Prevent animals and insects from entering the infected fields. Avoid the use of irrigation water coming from the infested field. Pull and burn all diseased plants when the infection is first starting. Burn the rice straw after rice harvest if the field is badly infected. The use of lime in the amount of 600 to 700 kilos per hectare is beneficial, besides correcting the soil acidity also. Plant resistant variety, such as Raminad Str. 3. Varieties, such as Elon-elon and Ramai may be used, but none so far have surpassed the resistance of Raminad Str. 3 in this respect.

### SUMMARY AND RECOMMENDATIONS

1. Soils where gravel and sand predominate, usually return to compact form after harrowing through the action of running water, so that it is necessary to cut the flow of water to avoid replowing.

2. Efficient implements, such as native plows and native steel harrow (suyod) be used instead of the bamboo harrow or spike-tooth board, for better ground preparation.

3. Size of the seedbed be 333 to 400 square meters per cavan of seed for a hectare of field under lowland condition, seedbed type No. 3; 500 square meters when sown in drill and 400 square meters when broadcasted under upland condition, seedbed types Nos. 1 and 2 respectively, and 30 to 45 square meters under "dapog" seedbed, type No. 4. Mucking of the soil preparatory to planting should last 18 to 21 days from the first to the third or fourth harrowings in order to get a better stand of the crop.

5. On poor soils the spacing of the hills should be 18 x 18 centimeters to 20 x 20 centimeters. Under this kind of soil, the rice plants seldom, if at all, prduce stools. On medium rich soils, the spacing between hills is 20 x 20 to 25 x 25 centimeters. Rice plants under this kind of soil produce a fair number of tillers so that there will be crowding if not properly spaced which may result in lodging. On soils that are rich, the spacing should be 25 x 25 centimeters or more depending upon the location and the variety to be planted.

6. For varieties with poor tillering characteristics, 5 to 6 seedlings should be planted per hill, and those with profuse stooling character, 3 to 4 seedlings per hill.

7. Irrigate the field 7 to 10 days after transplanting with a submergence depth of 8 to 10 centimeters; increasing this depth to 18 to 20 centimeters and maintaining this depth for three months, thereafter lowering the depth to 10 centimeters down to 8 centimeters to prevent weed growths. At dough stage, water should be completely drained off to hasten maturity.

8. Place the gates of succeeding paddies diagonally in order to prevent surface erosion.

9. Practice weeding by hand pulling to remove the rootstocks instead of merely topping the weeds by bolo or scythe.

10. Plant the right variety and practice seed selection.

# ILLUSTRATIONS

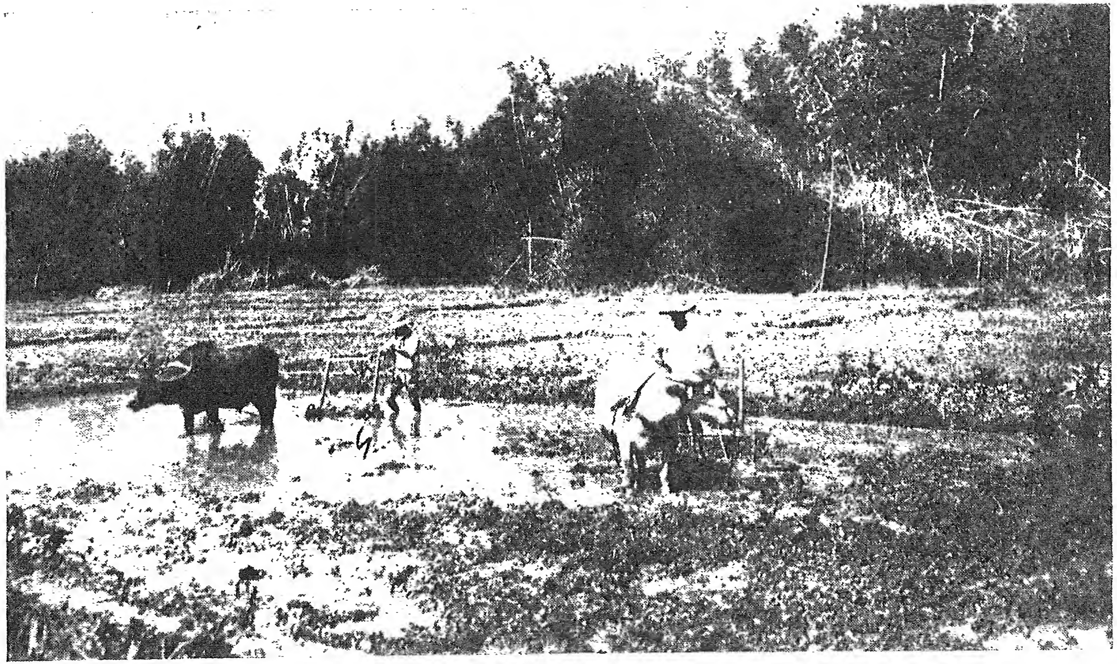

PLATE 1.

PLATE 2.

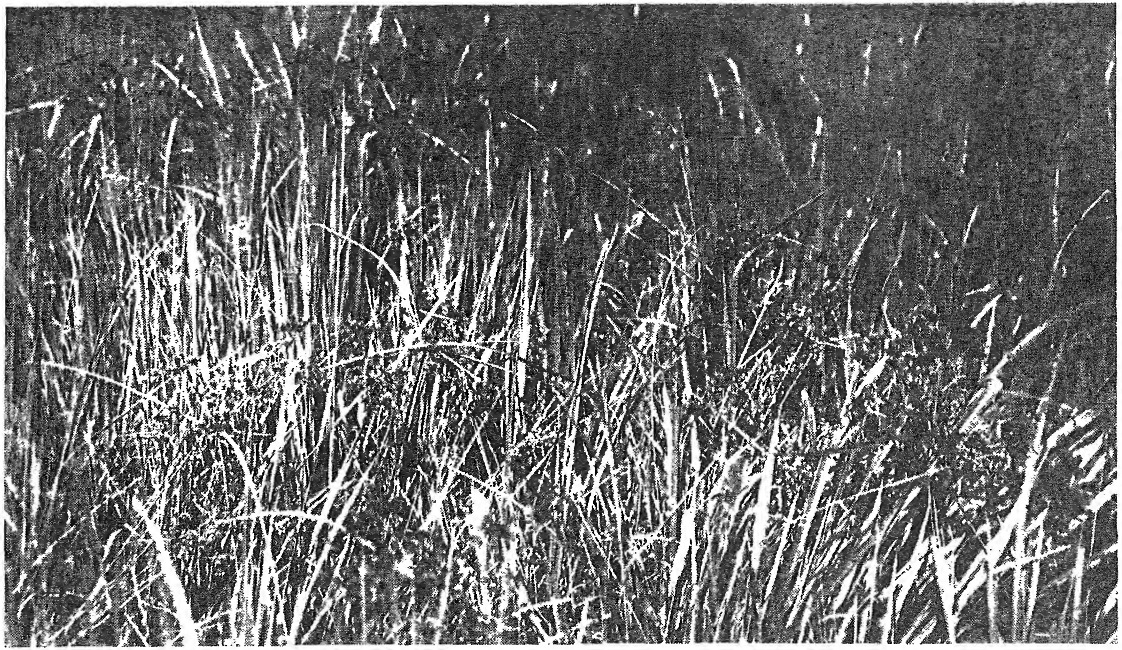

PLATE 3.

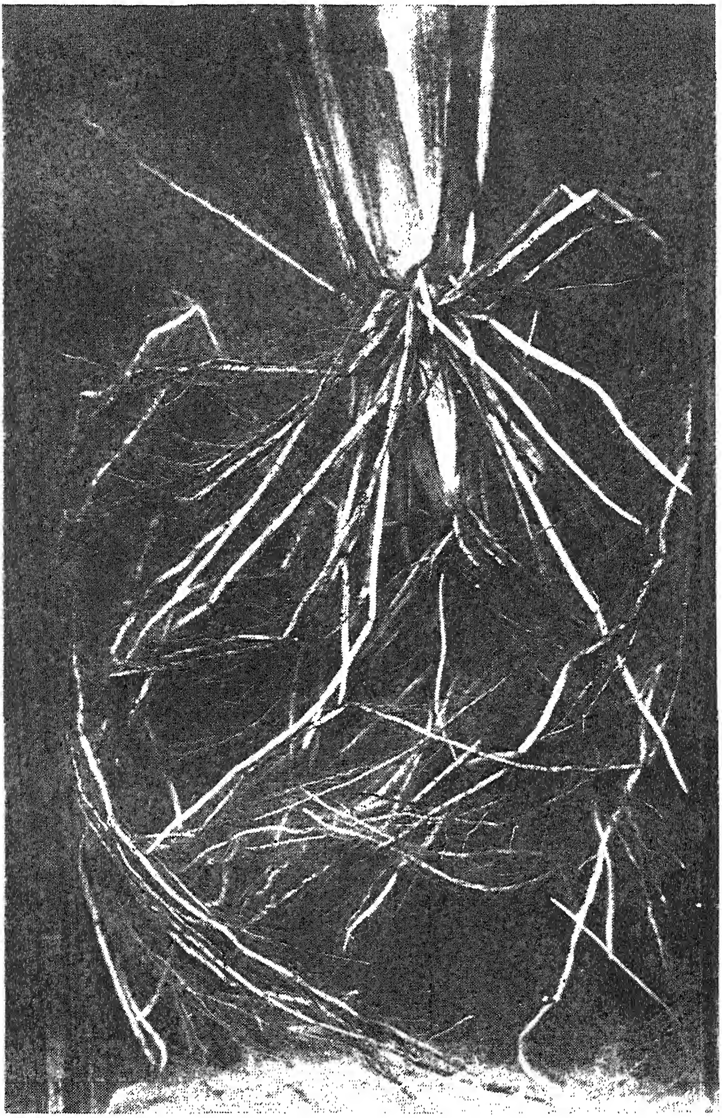

PLATE 4.

PLATE 5.

PLATE 6.

PLATE 7.

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# THE RATE OF PHOTOSYNTHESIS OF CARABAO MANGO LEAVES (*MANGIFERA INDICA* L.) UNDER FIELD CONDITIONS

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TWO PLATES AND FOUR TEXT FIGURES

Since the leaves are necessary for the manufacture of food for nutrition, growth, and reproduction, one of the primary objects in cultural practices is to maintain in each tree as many healthy leaves as possible. However, while a large total leaf-surface may be needed for this purpose, ultimately it is the efficiency of the individual leaf, that is, the milligrams of carbon dioxide ($CO_2$) assimilated by a given area of leaves per unit time that really determines the usefulness of the individual leaf.

The present study was started in October, 1934. The first few weeks of the experiment were spent mostly in acquiring experience in the proper use of the apparatus. This work necessitated numerous trials both with and without the use of the leaves of the plants. After acquiring enough experience, the writer conducted preliminary tests on potted grafted mango seedling which lasted about seven months. Then, later in June, 1935, when materials became available the experiment was carried extensively on a matured carabao mango tree, *Mangifera indica* L., grown under field conditions located in one portion of the experimental ground near the Administrative Building of the Bureau of Plant Industry. This work was extended to March, 1936, a period of almost one year.

The rate of photosynthesis of the leaves was determined by finding the difference between the amount of carbon dioxide absorbed from a continuous current of normal air and that from a similar current of air previously passed through a chamber in which an active living leaf was enclosed.

The subject of photosynthesis has been generally well treated of in previous literature. Ample bibliographies were listed by Stiles (24), Spoehr (23) and many others.

## APPARATUS USED IN THE STUDY

Apparatus closely similar to those devised and employed by Brown and Escombe (7) and by Heinicke and Hoffman (15) and aspirator tanks like those used by McLean (21), which serve to pull the air through the apparatus, were used in the present studies.

The principal parts of the apparatus (Plate 1) were the assimilation chambers, the five individual absorption units mounted on a common stand. The latter consisted of reservoir flasks and absorption towers, the flow meter, comprising the capillary tubes and improvised manometers, the aspirator tanks including their accessories, and the receptacle tanks which receive the water displaced in the respirator by the air.

*The assimilation chambers.*—These consisted of small rectangular envelope-chambers 8 by 15 cm. made up of cellophane paper, with openings at the bottom. (Plate 1, fig. A.) The chambers were prepared by folding loose sheaths of cellophane papers in packet-like form, closing all sides except the bottom. The opening at the bottom of the packet facilitated the insertion of the leaf and the tying together of the intake tube, the thermometer and the rubber tubings leading to the rest of the apparatus. The intake tube, 0.95 cm. in diameter glass tubing, 10 cm. long was bent slightly at almost obtuse angle at its free end. This served as a passage of air into the chamber. The thermometer, graduated from 0.0°C. to 100°C., recorded the temperature in the chamber. The chambers permitted the passage of normal amount of light (16) needed by the leaves.

Several U-tubes containing calcium chloride crystals (Plate 2, fig. A) were placed between the reservoir flasks and the assimilation chambers to collect the moisture that transpired from the leaves.

*The reservoir flasks.*—These consisted of 250-cc. capacity Erlenmeyer flasks of Pyrex glass. They were provided with

side necks for connections with the other parts of the apparatus (Plate 2, fig. B). Each flask was provided with rubber stopper with hole fitted with glass tubing about 20 cm. long that extended to the bottom of the flasks. The top end of the tube was connected to a rubber tubing to facilitate attachment to the rest of the apparatus. As will be shown later, these flasks contained the absorbent for the carbon dioxide that entered the apparatus.

*The absorption towers.*—The reservoirs were followed by five towers which were of Pyrex glass, about 2.5 cm. in diameter and 60 cm. long. Two of them were used as controls. They were held in vertical position by means of a wooden frame (Plate 2, fig. C) supported by a wooden bench, about 65 cm. high. With this arrangement, the apparatus was brought nearer the leaves used in the experiment. The basal ends of the towers were fitted with rubber stoppers having holes and glass tubings 0.95 cm. in diameter. These connected them with the reservoir flasks mentioned above. Just above the rubber stoppers at the base of the towers finely and uniformly folded beds of glass wools were placed so as to break the absorbent into small uniform bubbles. Thus certain scrubbing effect was produced, while the gas was brought in contact with the absorbent for a sufficiently long time. The top ends of the towers were connected to 100-cc. bottles (Plate 2, fig. D) each containing 60 cc. concentrated solution of sulphuric acid, for trapping the moisture, which otherwise clogged the capillary tubes (Plate 2, fig. E) and manometers (Plate 2, fig. F) which followed after the towers.

The capillary tubes were about 50 cm. long. They served to equalize the flow of air through the towers mentioned above. The manometers had a bore of about 0.35 cm. They were bent into U-shapes, one side being provided with short necks which connected them to the rest of the apparatus. The other end was left open. These manometers were protected by encasing them in flat small rectangular boards provided with scales (Plate 2, fig. G) for recording purposes. Approximately the same amount of liquid mercury was poured into each of the manometers. By means of this device, the pressure or velocity of the gas flowing into the respiratory tanks was regulated and recorded.

*The respiratory tanks.*—These followed the manometers. They were made up of iron drum (Plate 1, fig. C), and almost of the same size, each having about 50 gallons capacity. The

first one was used as a test tank and the other as a control tank. Both were placed side by side at vertical position on a tall table, about 105 cm. high (Plate 1). They were connected to the rest of the apparatus through holes bored on their top sides. This was accomplished by fitting small galvanized tubes into the tanks which in turn were fitted with rubber tubings to facilitate connections. The tanks were also provided with independent gauge and scales (Plate 1, fig. B) to record the volume of water displaced by the air entering the tanks. The tanks were also provided with outlets at the bottom by fitting snugly 1/2 inch faucets (Plate 1, fig. D) that could be opened simultaneously or regulated as desired. These faucets were connected to two arms of glass tubings (Plate 1, fig. F) and pulleys (Plate 1, fig. E) about one meter long each and 1.27 cm. diameter, and were protected by encasing them in bamboo poles of the same length and diameter. The arms were regulated by means of pulleys and tin can floats, having the same volume and size. With this device the volume of water displaced by the air entering the tanks could be regulated as desired. The water as being gradually displaced, flowed into the other tanks (Plate 1, fig. G) similar in form and size to the respiratory tanks.

## MATERIALS USED

The grafted mango plant referred to above which was used first in this experiment was planted in a large galvanized pail. The plant was healthy, about two meters high, and three to four years old. The soil is sandy loam and was fertilized in 1934 with nitrophoska at the rate of 400 kilogram per hectare or 40 grams per tree. The soil was watered every other day to keep it reasonably moist during the experiment.

It may be mentioned in passing that the leaves used in this preliminary test started to assimilate as soon as the leaves turned pale green, reaching the maximum rate in about 12 to 13 days after their appearance, or in this case between the 23rd and 26th of November. The maximum assimilation registered was about 20.0 mg. an hour per 100 square centimeters of leaf-area. However, after this maximum was reached, the activities of the leaves assumed a gradual fall registering minimum rates as low as 5.0 mg. and 4.0 mg. per hour per 100 square centimeters in March and in May, respectively, when the leaves were from 180 to 210 days old.

Having already obtained such preliminary information in the course of assimilation of mango leaves, the experiment was

carried extensively and as thoroughly as possible on a matured tree about 12 years old, and approximately 7 to 8 meters high, and with a trunk diameter of almost 25 cm. The tree was healthy and prolific as shown by previous yearly harvests. The soil around the tree is a fairly rich sandy loam, and made constantly moist due to its proximity to a garden faucet. The elevation of the soil is but a few meters above sea level.

The studies consisted in determining the rate of assimilation of a given area per hour, during the entire growth of the leaves from the early stage up to or near their incision period.

In order to secure the best materials possible, four healthy buds of the same age from different branches of the tree were selected. After they opened, only two were actually used, the others were maintained as substitutes in case those first selected would fail to develop until maturity. Three vigorous looking leaves were finally selected from the first bud, designating them as LA–1, LA–2, and LA–3. The other three from the second bud, were marked LB–1, LB–2, and LB–3. These two sets of leaves were used alternately throughout the entire period of the experiment. As may be shown later in a more detailed manner, the rate of assimilation was given in milligrams of carbon dioxide per hour per 100 square centimeters of the leaf-area. The method employed in finding the area of the leaf was essentially the same as that of Heinicke and Hoffman(14). An accurate print of the leaf was first obtained by placing its lower side against a white cardboard and then daubing the edges of the upper side with a fine cheese cloth moistened with a dilute aqueous solution of light green. The area of the print which corresponded to that of the leaf was measured by means of a planimeter.

## METHODS AND PROCEDURES

As may be seen from the following discussions, there are quite a number of salient points in the methods that need to be stressed. Obviously, the method required some degree of precision and care in order to arrive at the desired results.

*Preparation of acid and alkali solutions.*—The alkali used was KOH, having a concentration of almost 1/5 normal strength. This was preferred to $Ba(OH)_2$ solution because the latter was liable to precipitate in the towers and thus interferred with the return of the absorbent to the reservoirs below. The standard acid used was approximately 1/10 to 1/20 normal HCl.

The stock solutions of acid and alkali were kept separately in 20-liter demijohns in the laboratory. Burettes were employed

for transferring the alkali solution from the stock bottle to the flasks. This minimized the introduction of errors arising from the absorption of carbon dioxide from the air.

*Filling the reservoir flasks.*—The flasks were filled with 100 cc. KOH each. The volumes were made up to 200 cc. by adding 100 cc. of redistilled water obtained from the Bureau of Science. Utmost care was exercised to prevent the entrance of $CO_2$ from the air, which otherwise introduced errors to the results. Such errors, however, could not be entirely eliminated, so allowance for the exposure factor was provided by exposing a certain amount of KOH from the time of filling the flasks to the time when they were taken back to the laboratory for titration. It was found that the exposure factor ranged from 0.5 to 1.0 mg. $CO_2$ per flask every determination. These were taken into account in the calculations of the results. After filling the flasks, they were taken to the field well stoppered to be attached to the rest of the apparatus.

*Attaching the assimilation chamber.*—As soon as the intake tube, the thermometer, and the glass tubing were tied together near the petiole of the leaf, the cellophane-chamber was slipped over the leaf and tied snugly at the bottom so that there was no passage of air except through the intake tube. Care was taken not to injure the leaves so as not to impair their function.

Three chambers were used. The two control units were not provided with chambers but with free intake tubes that extended near the chambers. These were used to measure the $CO_2$ content of the air.

The experiment was then ready to be started. It may be stated in this connection, that before the experiment was actually started, all the connections were made air-tight as the apparatus would not run properly even with the slightest leak.

*Meteorological records.*—The temperatures of the air both in the open and in the shade, and that of the assimilation chamber were recorded during the experiment. Likewise, the temperatures of the tanks as well as the relative humidity of the air were noted. The readings of the barometric pressure were obtained from the records of the Weather Bureau. The conditions of the sky as well as the degree of exposure of the leaves to sunlight were noted each hour during the experiment. On account of the absence of illuminometer, the conditions of the sky, that is, the amount of sunlight striking the surface of the leaves was given in relative terms.

*Starting the experiment.*—The faucets of the aspirator tanks were opened simultaneously. The flow of water was regulated so as to have almost the same discharge from the respiratory tanks. As soon as the solution in the flasks rose to the towers and bubbled, the initial volumes of the tanks were read. Most of the experiments lasted three hours. Only a few were conducted for two hours.

The final volumes of the respirator tanks were read at every close of the experiment. The assimilation towers were always detached before the faucets were closed. This prevented the KOH solution from being sucked into the tank. The towers were thoroughly washed with about 150 cc. of distilled water which was allowed to run into the flasks. This insured the complete recovery of all the $CO_2$ absorbed by the KOH solution(1). The flasks were then disconnected, stoppered tightly, and brought back to the laboratory for titration.

*Titrating the KOH solution.*—The contents of each of the five flasks were transferred into 500-cc. volumetric flasks, rinsing the former thoroughly with distilled water. The solutions were treated with 10 cc. of 25 per cent Barium chloride solution and shaking the mixture vigorously to complete the precipitation. Finally, each volume was made up to 500 cc. and transferred to well stoppered one-liter bottles. They were allowed to stand for some time to allow the precipitates to settle at the bottom of the bottles.

As soon as the precipitates have settled down in each bottle, 50-cc. portions of the clear liquid were drawn out with a pipette and titrated against a standard HCl acid solution using Phenolpthalein as an indicator. At least five replications from each bottle were made so as to bring the errors to the minimum. Phenolpthalein was used because it shows the completion of simple KOH-HCl reaction; it has a distinct end point, besides being sensitive to $CO_2$.

## METHODS OF CALCULATING RESULTS

Suppose we take as an example, one unit, that is, one leaf, attached to a flask and a tower. In this specific case, 50 cc. of 0.2260 N KOH was neutralized by 17.2 cc. of 0.1150 normal HCl, or the total 500 cc. alkali required 172.0 cc. of the acid. In this case, the acid equivalent of 1 cc. of the alkali, which was obtained by dividing its normality by that of the acid, is 1.9652 cc.;

and its $CO_2$ equivalent as calculated from the usual chemical equation was 4.972 mg. $2KOH+CO_2 \rightarrow K_2CO_3+H_2O$
$K_2CO_3+BaCl_2 \rightarrow BaCO_3+2KCl$.

Now, in order to find the amount of alkali left after the original volume had reacted with the $CO_2$, that entered the apparatus, divide 172.0 cc. by 1.9652 cc., the acid equivalent of 1 cc. KOH, giving 87.52 cc. KOH. This amount is an excess of the original KOH solution or the amount that had not been reacted by $CO_2$.

Comparing the two control units, that is, those through which "fresh air" passed with the test referred above, the amount of KOH left after reacting with $CO_2$ was 91.59 cc. and 87.01 cc., respectively, or with an average of 89.30 cc. This amount of KOH represents the remainder or excess from the original solution in the two towers after it reacted with the entire amount of $CO_2$ that entered the apparatus, since there was no leaf to absorb a part or all of the carbon dioxide.

Now, therefore, in order to find the assimilation of the leaf attached to the tower referred above, substract 87.52 cc. from 89.30 cc., leaving 1.78 cc. Multiplying this remainder by 4.972 mg. $CO_2$, the acid equivalent of 1 cc. KOH, will give 8.85016 mg. $CO_2$, the assimilation of the leaf within a period of three hours. Finally, to find the apparent assimilation of the leaf per 100 sq. cm. per hour divide 100 by 39.10 sq. cm., the area of the leaf, and multiply the quotient by 1/3 and 8.85016 mg. $CO_2$ which gives 7.54 mg. $CO_2$. This represents the assimilation per 100 sq. cm. of leaf area per hour. From this will be substracted the exposure factor as suggested by Blackman and Matthei(1) which in this case is only 0.5 mg. $CO_2$. The final figure 7.04 mg. $CO_2$ corresponds to the net assimilation per hour per 100 sq. cm. leaf area.

## EXPERIMENTS AND RESULTS

*Dependability of the apparatus.*—It was recognized at the outset of the experiments that the reliability of the results depended largely on the $CO_2$ absorption and also on such other factors as the rate of flow of air through the towers, the strength of the solution used and the length of time it was in contact with the air, duration of the experiment, size of bubbles, and the temperature of the liquid. Accordingly, these factors have been considered during the progress of the experiment.

The results of a few control experiments carried at various times under varying temperatures and atmospheric pressures are given in the tables below:

Table 1 consists of determinations made in the morning while Table 2 gives those carried in the afternoon. Both tables indicate the results of a few daily tests and few at weekly and monthly intervals.

Table 1 presents some 20 tests, 11 of which show 3 to 3.5 parts per 10,000 volumes of air, while the rest were below this proportion. The lowest proportion, 2.46 parts per 10,000 was recorded on December 10, 1935, while the highest, 3.48 parts per 10,000 was recorded in June of the same year. These variations were not surprising in view of the findings of Brown and Escombe (5), (6). These authors also found the same variations. It is interesting to note that except those recorded on September 13 and October 25 respectively all the high proportions occurred in the months of June and July. The low figures were observed during the months of August, November, and December. There was one exception, however, and that was in July when the proportion almost reached to 3 parts per 10,000. This is equivalent to the general accepted amount of carbon dioxide in 10,000 volumes of dry air.

TABLE 1.—*Carbon dioxide in the air expressed in volumes per 10,000 volumes of air. Computed from data obtained during three-hour periods between 8.30 and 11.30 a. m.*

| Date | Volume of air in liters | Mg. $CO_2$ per liter of air | Computed $CO_2$ content of the air, expressed in volumes per 10,000 volumes of air |
|---|---|---|---|
| June 17, 1935 | 116.2 | 0.6482 | 3.30 |
| June 18, 1935 | 138.9 | 0.6184 | 3.15 |
| June 19, 1935 | 140.9 | 0.6372 | 3.26 |
| June 20, 1935 | 131.5 | 0.6535 | 3.33 |
| June 21, 1935 | 148.8 | 0.6844 | 3.48 |
| July 1, 1935 | 149.7 | 0.5623 | 2.86 |
| July 7, 1935 | 141.2 | 0.6589 | 3.35 |
| July 15, 1935 | 147.5 | 0.5866 | 2.99 |
| July 25, 1935 | 126.8 | 0.6636 | 3.38 |
| August 12, 1935 | 133.6 | 0.5346 | 2.72 |
| August 26, 1935 | 135.5 | 0.5623 | 2.87 |
| September 13, 1935 | 121.8 | 0.6449 | 3.24 |
| September 28, 1935 | 123.2 | 0.6239 | 3.18 |
| October 14, 1935 | 133.2 | 0.5587 | 2.84 |
| October 25, 1935 | 113.9 | 0.6611 | 3.37 |
| November 6, 1935 | 121.7 | 0.6012 | 3.06 |
| November 27, 1935 | 114.2 | 0.4975 | 2.53 |
| December 10, 1935 | 117.7 | 0.4830 | 2.46 |
| December 27, 1935 | 124.7 | 0.5815 | 2.96 |
| January 6, 1936 | 118.2 | 0.5843 | 2.82 |

The figures in the afternoon tests, excepting that of January 16, 1936, were high in June, July, and September, respectively. The low figures occurred in November and December, 1935 and March, 1936. In this case, the highest figure was noted in July, 1935, while the lowest in December of the same year.

Apparently, the results of the morning and afternoon tests were more or less in accord with each other.

Perhaps, the augmented amount of $CO_2$ in the air during the early part of the experiment, that is, from June to July

TABLE 2.—*Carbon dioxide in the air expressed in volumes per 10,000 volumes of air. Computed from data obtained during three-hour periods between 1 and 4 p. m.*

| Date | Volume of air in liters | Mg. $CO_2$ per liter of air | Computed $CO_2$ content of the air, expressed in volumes per 10,000 volumes of air |
|---|---|---|---|
| June 25, 1935 | 139.2 | 0.6525 | 3.31 |
| June 26, 1935 | 139.9 | 0.6334 | 3.22 |
| June 27, 1935 | 140.8 | 0.5979 | 3.04 |
| June 28, 1935 | 145.3 | 0.6258 | 3.18 |
| July 1, 1935 | 140.4 | 0.6311 | 3.21 |
| July 7, 1935 | 141.2 | 0.6589 | 3.35 |
| July 25, 1935 | 132.5 | 0.6465 | 3.29 |
| July 31, 1935 | 140.9 | 0.6611 | 3.36 |
| August 7, 1935 | 122.5 | 0.5555 | 2.83 |
| August 21, 1935 | 132.0 | 0.5609 | 2.85 |
| September 5, 1935 | 95.5 | 0.6424 | 3.27 |
| September 23, 1935 | 131.4 | 0.6486 | 3.30 |
| October 25, 1935 | 120.5 | 0.5933 | 3.02 |
| October 30, 1935 | 111.3 | 0.6365 | 3.24 |
| November 6, 1935 | 119.9 | 0.5217 | 2.65 |
| November 13, 1935 | 108.2 | 0.6258 | 3.19 |
| December 16, 1935 | 105.3 | 0.4909 | 2.50 |
| January 16, 1936 | 133.0 | 0.6528 | 3.31 |
| January 29, 1936 | 123.3 | 0.5849 | 2.97 |
| February 13, 1936 | 129.4 | 0.6222 | 3.17 |
| February 26, 1936 | 121.9 | 0.5986 | 3.05 |
| March 4, 1936 | 136.6 | 0.5073 | 2.58 |

was due to the respiratory activities of the leaves. Under this period, the buds of the plant under experiment were in great activity. It seems likely that at this stage oxygen was taken in while an equal amount of $CO_2$ was given off.

*Air supply and rate of assimilation.*—Previous investigators (4), (20), (1), and (23) have found that if the amount of $CO_2$ is enriched, the assimilations of the leaves increased several times. On the other hand, assimilation is reduced in a limited volume of air due to the small amount of $CO_2$.

The writer's experiments were carried under conditions where the amount of $CO_2$ present depended on the quantity of air that entered the assimilation chambers. In other words, normal rates of assimilations were governed by the supply of air per one square centimeter leaf-surface enclosed.

Heinicke and Hoffman (14) concluded from their experiments that about 2 to $2\frac{1}{2}$ liters of air per square centimeter of leaf-surface, enclosed in a chamber would be just enough to supply the amount of $CO_2$ that just equalled the amount of $CO_2$ available under natural conditions. They stated that the rate of assimilations under this condition was normal but below this amount the rate would be subnormal.

According to our results, the number of liters per square centimeter of leaf-area per hour of the A-series leaves in the morning, ranged from 0.37 to 2.93 or an average of 0.95 liter per square centimeter per hour. In the afternoon it ranged from 0.47 to 2.18 liters, or an average of 0.79 liter per square centimeter per hour. The daily average for these leaves was 0.87 liter per square centimeter of leaf-area per hour.

The number of liters per square centimeter of leaf-surface per hour of the B-series leaves in the morning ranged from 0.42 liter to 1.61 liters, or an average of 0.62 liter per square centimeter per hour. Those in the afternoon ranged from 0.42 to 1.12 liters, or an average of 0.63 liter per square centimeter per hour. The daily average for all the leaves was 0.80 liter per square centimeter of leaf-surface per hour.

The above figures, compared with those of Heinicke's and Hoffman's (14) are rather low. It is, however, interesting to note that Brown and Escombe (4) gave figures as low as 0.2 liter per square centimeter per hour, while McLean's were much less.

In considering the amount of $CO_2$ supplied, the effects of the movement of air over the leaf enclosed in the chamber should be determined also. Brown and Escombe (3) and others have worked on this, but mainly on higher rates. Heinicke and Hoffman (14) reported that the mean velocity of the air movement over the leaf in the cup chambers they used was about 7 meters per minute. In the writer's experiments the air movement recorded was only about 2 meters per minute. Perhaps the differences were due to the size of the assimilation chambers used and the manner by which the air was pulled through the apparatus. It is interesting to note, however, that the air entered the writer's apparatus about 10 times as fast as in McLean's

apparatus in which aspirator tanks were also used for pulling the air through the system.

As already mentioned elsewhere, the first set of three leaves was designated respectively as LA–1, LA–2, LA–3, and those of the second were labeled LB–1, LB–2, and LB–3. These leaves were borne by middle-age branches on the northern half of the crown of the tree.

Leaves LA–1 and LA–3 were both attached on lateral branches, while leaf LA–2 was borne by a terminal branch. They were all situated northwest in the crown of the tree.

Leaves LB–1 and LB–2 were also on lateral branches situated northwest, while LB–3 was borne by a terminal branch, situated directly north.

The daily exposure of the leaves as observed and recorded hourly throughout the experiment is summarized as follows: Leaf LA–1, excepting between 8 and 9 o'clock in the morning and between 12 and 1 in the afternoon, when they were partially shaded, the exposure up to 4 o'clock was very adequate. Leaf LA–2 was partially shaded at 8 o'clock a. m. and 12 noon, but well exposed the rest of the day up to 4 p. m. Leaf LA–3 was well exposed from morning up to 3 p. m. but partially shaded towards 4 p. m. Excepting between 12 to 1 p. m. when it was partially shaded, LB–1 was adequately exposed till the closing of the experiment at 4 p. m. Leaf LB–2 was partially shaded between 8 to 9 a. m. and 12 noon, but it was well exposed the rest of the day. Leaf LB–3 received sunlight throughout the day.

It is thus evident that the leaves were sufficiently well exposed to sunlight each day, except for a brief period in the morning and at noon, respectively, when few of them were partially shaded. Heinicke and Hoffman(14) stated that generally a leaf that is poorly exposed would still receive more than 1,000-foot candles of light. They stated further that the amount of light reaching the surface of an active leaf varies from 50-foot candles on a dull cloudy day, to 11,000-foot candles on a clear bright day. They estimated that about 12,000-foot candles are equivalent to one-eighth of full sunlight.

The prevailing weather conditions and the mean temperatures during the experiment were also given. Because of the absence of illuminometer for accurate measurement, the light conditions were given in relative terms which for the sake of clearness are illucidated herewith. The term "clear" was used to

mean that the sunshine persisted the whole day; "Partly cloudy," when passing clouds occupied about one-half of the sky and persisted only one-half of the day, either in the morning or in the afternoon; "cloudy," when two-thirds or more of the sky

TABLE 3.—*Fluctuation in photosynthetic activity of leaves A–1, A–2 and A–3 (Average of three-hour determinations between 8.30 a. m. and 11.30 a. m.).*

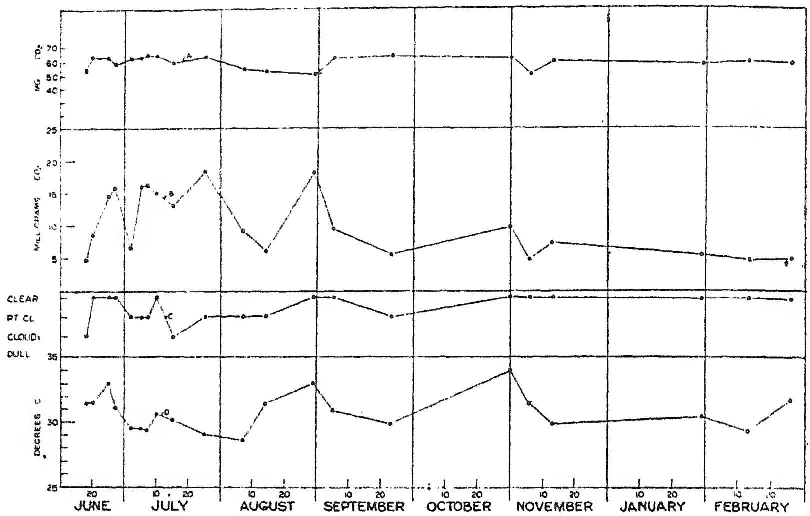
| Date | Average $CO_2$ assimilations (Mg. Hr. 100 $Cm_2$) | Sky | Temperature | | |
|---|---|---|---|---|---|
| | | | Minimum | Mean | Maximum |
| 1935 | | | °C. | °C. | °C. |
| June 15 | -1.3 | Cloudy | 27.0 | 30.3 | 33.5 |
| June 17 | 10.7 | Clear | 27.0 | 32.9 | 38.8 |
| June 19 | 11.8 | Clear | 27.0 | 32.3 | 37.5 |
| June 21 | 13.4 | Clear | 27.5 | 31.7 | 35.9 |
| June 26 | 17.2 | Cloudy | 27.0 | 30.4 | 33.8 |
| June 28 | 24.9 | Clear | 28.0 | 30.0 | 32.0 |
| July 1 | 10.2 | Clear | 28.5 | 30.5 | 32.5 |
| July 3 | 17.1 | Clear | 25.0 | 28.8 | 32.6 |
| July 6 | 20.2 | Partly cloudy | 27.0 | 28.5 | 30.0 |
| July 9 | 23.2 | Clear | 26.5 | 29.8 | 33.0 |
| July 11 | 11.5 | Clear | 28.0 | 30.6 | 33.1 |
| July 13 | 15.6 | Dull | 25.0 | 26.7 | 28.3 |
| July 16 | 12.5 | Clear | 25.0 | 29.1 | 33.2 |
| July 26 | 12.2 | Cloudy | 27.0 | 28.2 | 29.3 |
| July 31 | 13.1 | Clear | 25.9 | 31.1 | 36.3 |
| August 8 | 16.5 | Clear | 30.5 | 30.8 | 31.1 |
| August 12 | 14.5 | Clear | 26.8 | 28.8 | 30.9 |
| August 16 | 15.8 | Clear | 29.1 | 30.0 | 30.8 |
| August 21 | 10.8 | Clear | 28.9 | 29.8 | 30.7 |
| August 26 | 17.3 | Clear | 28.8 | 30.4 | 32.2 |
| September 9 | 10.8 | Clear | 28.5 | 30.7 | 32.8 |
| September 13 | 14.7 | Clear | 30.6 | 31.8 | 32.9 |
| September 25 | 15.9 | Clear | 29.5 | 30.9 | 32.3 |
| October 2 | 9.8 | Cloudy | 27.9 | 31.2 | 34.4 |
| October 14 | 8.7 | Clear | 28.8 | 30.8 | 32.8 |
| October 25 | 6.5 | Clear | 27.5 | 31.0 | 34.4 |
| November 2 | 4.9 | Clear | 26.3 | 31.0 | 35.6 |
| November 9 | 4.5 | Cloudy | 25.9 | 28.2 | 30.5 |
| November 20 | 7.3 | Clear | 26.0 | 29.7 | 33.3 |
| November 23 | 5.4 | Clear | 25.4 | 29.4 | 33.4 |
| November 29 | 7.7 | Clear | 27.5 | 29.7 | 31.8 |
| December 10 | 7.4 | Partly cloudy | 26.5 | 29.7 | 32.8 |
| December 16 | 9.6 | Clear | 27.8 | 31.2 | 34.5 |
| December 27 | 7.5 | Clear | 26.3 | 31.0 | 35.6 |

were dark for about one day; and "dull," when the sky was completely cloudy or dark the whole day and generally followed by short showers or rains. The days during the experiments were usually accompanied by a gentle breeze to slightly fast winds.

The results of the determinations on the first set of leaves in the morning are shown in Table 3, and those in the afternoon in Table 4.

Table 3 represents the average determinations of leaf LA-1, LA-2, and LA-3 in the morning, while Table 4 gives the average afternoon determinations of the same leaves.

As may be seen in the graph corresponding to Table 3, the photosynthetic activity of the leaves were rather irregular; on June 15, the leaves showed a negative assimilation. Later on, however, it ascended to a considerable height on June 28, about two weeks after the experiment was well under way. The rate then dropped on July 1, but rose again on July 6 and 9,




GRAPH 1.—Average $CO_2$ assimilation by leaves A-1, A-2, A-3 during three-hour determinations between 8:30 a. m. and 11:30 a. m. from June to December.

respectively. Finally, it declined on July 11 and remained at this point for sometime with but slight variations until finally on October 2, another conspicuous drop was sustained, the lowest minimum being recorded on November 9. From this time on, although slightly irregular, the course of activity was not so conspicuously variable as in the first months.

Apparently, the maximum activity of the leaves occurred between June 28 and October 2, when the leaves were from 12 to 100 days old. It was evident that the external conditions influenced the activities of the leaves as clearly shown during the latter part of June through July, and in November and December, respectively. The intervening time between these

two periods, however, that is, from July to November did not show close correlations between the rate of assimilations and weather conditions. Perhaps, in this case the internal factors, inherent in the plants themselves played a certain rôle.

Referring to Table 3 and its corresponding graph, it may be seen that the first assimilations were low, but later a steady rise was noted until the maximum rate was reached on the 28th day of June. As mentioned elsewhere in this paper, the maximum rate during the morning tests was reached about this

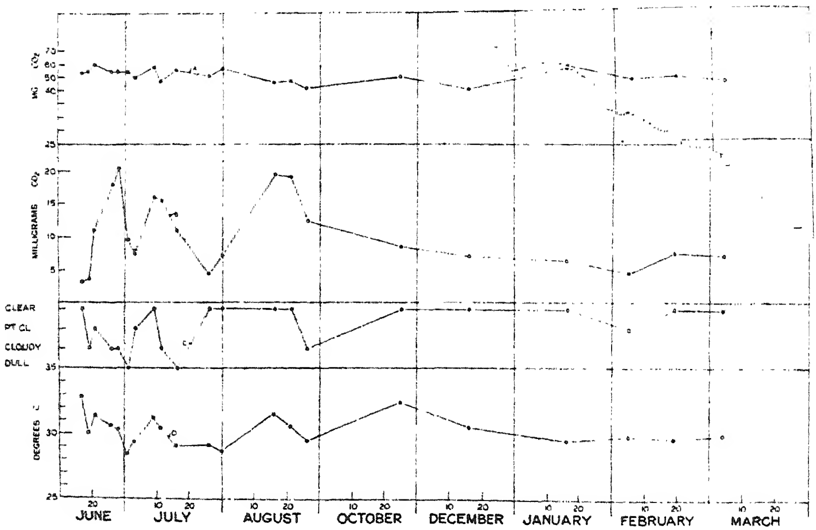
TABLE 4.—*Fluctuation in photosynthetic activity of leaves A–1, A–2 and A–3 (average of three-hour determinations between 1 p. m. and 4 p. m.)*

| Date | Average $CO_2$ assimilations (Mg. Hr. 100 $Cm_2$) | Sky | Temperature | | |
|---|---|---|---|---|---|
| | | | Minimum | Mean | Maximum |
| 1935 | | | °*C.* | °*C.* | °*C.* |
| June 17 | 3.2 | Clear | 27.0 | 32.9 | 38.8 |
| June 19 | 3.7 | Cloudy | 27.5 | 30.0 | 32.5 |
| June 21 | 11.1 | Partly cloudy | 27.5 | 31.4 | 35.3 |
| June 26 | 18.0 | Cloudy | 27.0 | 30.5 | 34.0 |
| June 28 | 20.5 | Cloudy | 28.0 | 30.3 | 32.5 |
| July 1 | 9.6 | Dull | 24.3 | 28.5 | 32.6 |
| July 3 | 7.3 | Partly cloudy | 24.5 | 29.3 | 34.0 |
| July 9 | 16.0 | Clear | 28.0 | 31.2 | 34.3 |
| July 11 | 15.8 | Cloudy | 27.8 | 30.4 | 33.1 |
| July 16 | 11.0 | Dull | 25.0 | 29.0 | 33.0 |
| July 26 | 4.3 | Clear | 27.0 | 29.2 | 31.3 |
| July 31 | 7.0 | Clear | 26.0 | 28.7 | 31.3 |
| August 16 | 19.6 | Clear | 30.1 | 31.5 | 32.9 |
| August 21 | 19.3 | Clear | 29.0 | 30.5 | 31.9 |
| August 26 | 12.6 | Cloudy | 26.8 | 29.4 | 32.0 |
| October 25 | 8.5 | Clear | 27.6 | 32.3 | 37.0 |
| December 16 | 7.0 | Clear | 24.8 | 30.4 | 36.0 |
| January 16 | 6.3 | Clear | 24.5 | 29.5 | 34.4 |
| February 5 | 4.7 | Partly cloudy | 27.0 | 29.7 | 32.4 |
| February 19 | 7.7 | Clear | 25.7 | 29.5 | 33.3 |
| March 4 | 7.5 | Clear | 28.1 | 30.0 | 31.8 |

time also. On July 1, the activity went down, but increased again on the 9th, and about the end of the same month, it suddenly dropped. A few days later, it was noted that the leaves resumed their activity, attaining successive maximum levels on August 16 and 26. The leaves then became inactive until the close of the experiment, that is, after the leaves were about 260 days old.

Our observations showed that the influence of weather conditions to the activities of the leaves were more pronounced on June through October than later in the year.

Table 4 gives the afternoon determinations of the A-series of leaves. It may be noted that the performance, in the afternoon follow in general the trend of activities in the morning. As already intimated above, the highest rates of assimilations occurred mostly from the latter part of the first month to the latter part of the fourth month, after which time they showed a downward trend. Excepting that of July 26 and 31, the daily variations were likewise in general accord with the prevailing weather conditions. The results could be clearly seen in graph 2.




GRAPH 2.—Average $CO_2$ assimilation by leaves A-1, A-2, A-3 during three hour determinations between 1:00 p. m. and 4:00 p. m. from June to March.

Tables 5 and 6 give the morning and afternoon determinations of the leaves LB–1, LB–2, and LB–3. The data are plotted as shown in graphs 3 and 4.

The graph above shows that the maximum rate of the activity of the leaves occurred on June 27. It dropped on July 2, but later rose again, attaining high levels consecutively on the 14th and 29th of August, and on the 5th to the 11th of September. Apparently, resting the leaves at a few days intervals as in this case, stimulated their activity as shown by the September determinations. The leaves were not used until the early part of September. From this date, however, the activity dropped. Evidently, these leaves manifested a considerable activity between the latter part of June to the middle of September. In some instances, the external factors were in close accord with

the activities of the leaves, especially in June to early part of September.

Table 6 and the accompanying graph show the afternoon determinations of leaves, LB–1, LB–2, and LB–3. The maximum rates of activities of leaves were noted on June 25 and 27 and on July 5 to 25, respectively. Another maximum was recorded

TABLE 5.—*Fluctuation in photosynthetic activity of leaves B–1, B–2, and B–3 (average of three-hour determinations between 8.30 a. m. and 11.30 a. m.).*

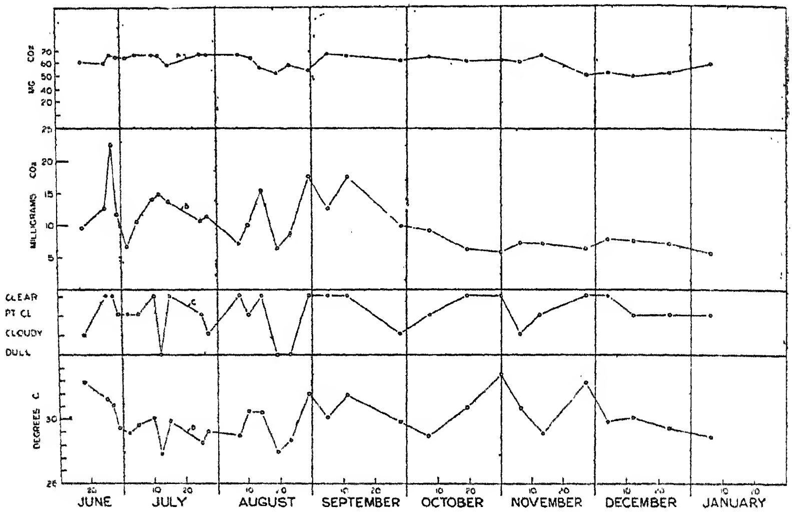
| Date | Average $CO_2$ assimilations (Mg. Hr. 100 Cm²) | Sky | Temperature | | |
|---|---|---|---|---|---|
| | | | Minimum | Mean | Maximum |
| | | | °C. | °C. | °C. |
| June 18, 1935 | 9.4 | Cloudy | 27.0 | 32.3 | 37.5 |
| June 25, 1935 | 12.7 | Clear | 28.7 | 31.5 | 34.3 |
| June 27, 1935 | 22.5 | Clear | 27.8 | 31.6 | 35.4 |
| June 29, 1935 | 11.5 | Partly cloudy | 28.3 | 29.4 | 30.4 |
| July 2, 1935 | 7.2 | Partly cloudy | 24.3 | 28.8 | 33.3 |
| July 5, 1935 | 10.5 | Partly cloudy | 27.7 | 29.5 | 31.2 |
| July 10, 1935 | 14.1 | Clear | 27.8 | 30.1 | 32.3 |
| July 12, 1935 | 14.9 | Dull | 25.8 | 27.3 | 28.8 |
| July 15, 1935 | 13.7 | Clear | 27.5 | 29.8 | 32.1 |
| July 25, 1935 | 10.7 | Partly cloudy | 27.3 | 28.1 | 28.8 |
| July 27, 1935 | 11.1 | Cloudy | 26.5 | 29.0 | 31.5 |
| August 7, 1935 | 7.0 | Clear | 25.7 | 28.7 | 31.6 |
| August 10, 1935 | 10.0 | Partly cloudy | 30.2 | 30.6 | 31.0 |
| August 14, 1935 | 15.4 | Clear | 29.6 | 30.5 | 31.4 |
| August 19, 1935 | 6.2 | Dull | 26.3 | 27.4 | 28.5 |
| August 23, 1935 | 8.7 | Dull | 26.9 | 28.3 | 29.7 |
| August 29, 1935 | 17.6 | Clear | 31.3 | 31.9 | 32.6 |
| September 5, 1935 | 12.7 | Clear | 28.0 | 30.1 | 32.2 |
| September 11, 1935 | 17.8 | Clear | 29.8 | 31.8 | 33.9 |
| September 28, 1935 | 10.0 | Cloudy | 26.8 | 29.7 | 32.6 |
| October 7, 1935 | 9.2 | Partly cloudy | 25.5 | 28.6 | 31.6 |
| October 19, 1935 | 6.2 | Clear | 28.8 | 30.8 | 32.8 |
| October 30, 1935 | 5.9 | Clear | 27.9 | 33.4 | 38.8 |
| November 6, 1935 | 7.2 | Cloudy | 26.0 | 30.8 | 35.6 |
| November 13, 1935 | 7.1 | Partly cloudy | 26.4 | 28.9 | 31.3 |
| November 27, 1935 | 6.3 | Clear | 29.0 | 32.8 | 36.5 |
| December 4, 1935 | 7.9 | Clear | 26.3 | 29.7 | 35.0 |
| December 12, 1935 | 7.7 | Partly cloudy | 26.8 | 30.1 | 33.5 |
| December 23, 1935 | 7.0 | Partly cloudy | 23.5 | 29.3 | 35.1 |
| January 6, 1936 | 5.6 | Partly cloudy | 24.9 | 28.6 | 32.3 |

on August 29. The first minimum rates were obtained consecutively on July 2, August 7 and 14, and lastly on September 5, while the later minima were noted on November 6 and on February 13. Although there were few exceptions, the activities of the leaves were to some extent influenced by external conditions.

In general, the activities of the leaves were correlated with the external conditions obtaining during the time of determina-

tions. For instance, most of the maximum rates of assimilations occurred during clear days with a goodly amount of sunshine. On the other hand, the minimum rates were generally associated with cloudy or dull days. Some exceptions were noted. For instance, on June 26 and 28 of the afternoon determination, and on July 6, of the morning determination of leaves A–1, A–2, and A–3 although it was cloudy, and the mean temperature low, the assimilations were comparatively high.

On the other hand, on November 2 and 23 although both days were clear with a goodly amount of sunshine, the corresponding assimilations were low. Perhaps in this case, the inactivity was partly due to the advanced stage of the leaves. The low rates




GRAPH 3.—Average $CO_2$ assimilation by leaves B-1, B-2, B-3 during three hours determinations between 8:30 a. m. and 11:30 p. m. from June to January.

on July 31 and on August 21, however, can not be attributed to old age. Perhaps the variations were due to the influence of the prevailing external factors.

Notwithstanding these few isolated contradictory figures, the results of the experiment in general indicated better rates of assimilations during bright sunshiny days and lower rates during inclement weather. This trend of activity persisted throughout the expirements.

The sharp daily variations in the activities of the leaves occurred from the latter part of June through August and September. The variations assumed a downward trend till the termination of the experiment. In some cases, however, the

last determinations showed upward tendencies which could not be explained. These findings corroborated those of Heinicke and Hoffmann(14) in the case of their studies with the apple

TABLE 6.—*Fluctuation in photosynthetic activity of leaves B–1, B–2, and B–3 (average of three-hour determinations between 1 p. m. and 4 p. m.).*

| Date | Average $CO_2$ assimilations (Mg. Hr. 100 $Cm^2$) | Sky | Temperature | | |
|---|---|---|---|---|---|
| | | | Minimum | Mean | Maximum |
| | | | °C. | °C. | °C. |
| June 18, 1935 | 4.7 | Cloudy | 26.0 | 31.3 | 36.6 |
| June 20, 1935 | 8.4 | Clear | 27.5 | 31.4 | 35.2 |
| June 25, 1935 | 14.8 | Clear | 28.8 | 32.9 | 35.0 |
| June 27, 1935 | 16.0 | Clear | 28.0 | 31.0 | 34.0 |
| July 2, 1935 | 6.7 | Partly cloudy | 24.5 | 29.5 | 34.5 |
| July 5, 1935 | 16.0 | Partly cloudy | 27.5 | 29.5 | 31.4 |
| July 7, 1935 | 16.4 | Partly cloudy | 27.0 | 29.3 | 31.5 |
| July 10, 1935 | 15.1 | Clear | 27.8 | 30.5 | 33.2 |
| July 15, 1935 | 13.1 | Cloudy | 26.3 | 30.1 | 33.9 |
| July 25, 1935 | 18.3 | Partly cloudy | 27.5 | 29.0 | 30.5 |
| August 7, 1935 | 9.1 | Partly cloudy | 25.6 | 28.5 | 31.3 |
| August 14, 1935 | 6.1 | Partly cloudy | 29.8 | 31.3 | 32.8 |
| August 29, 1935 | 18.2 | Clear | 32.1 | 32.9 | 33.7 |
| September 5, 1935 | 9.5 | Clear | 28.0 | 30.9 | 33.7 |
| September 23, 1935 | 5.8 | Partly cloudy | 28.8 | 29.8 | 30.7 |
| October 30, 1935 | 9.9 | Clear | 28.9 | 34.3 | 39.7 |
| November 6, 1935 | 5.0 | Clear | 25.9 | 31.4 | 36.8 |
| November 13, 1935 | 7.7 | Clear | 26.3 | 29.8 | 33.2 |
| January 29, 1936 | 5.5 | Clear | 27.9 | 30.7 | 33.5 |
| February 13, 1936 | 5.0 | Clear | 27.0 | 29.5 | 31.9 |
| February 26, 1936 | 5.1 | Clear | 31.0 | 31.8 | 32.5 |

leaves. Majority of the determinations, however, were in accord with the prevailing weather conditions.

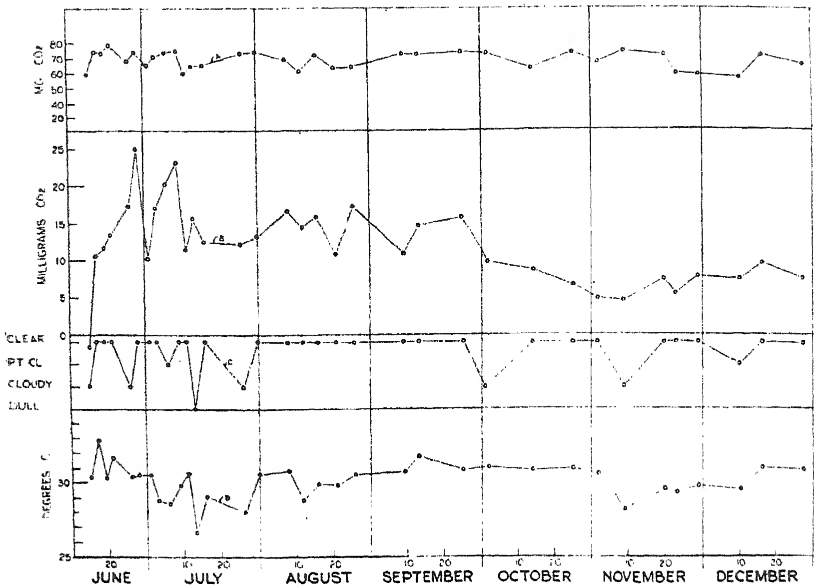
Apparently, the leaves assimilated most during their light green stage, especially in the morning. The same findings were noted by McLean(21) in his studies with coconut, abacá, and sugar cane.

As the leaves advanced in stage about 7½ to 8½ months old, and approached their incision period, they became inactive until finally they were replaced by the new leaves resulting from the buds of the following season.

## DISCUSSION

The rates of photosynthesis of mango leaves were found to vary each day throughout the experiment. No two or more successive determinations for any length of time were the same. A maximum value may be followed by a low rate, or vice versa, depending on the conditions obtaining during the determinations.

Such variations in the writer's results were expected since in literature (23), (24), (21) and other sources; it has been shown that the photosynthetic activities of different crops showed wide variations in rates.




GRAPH 4. Average $CO_2$ assimilation by leaves B1, B-2, B-3, during three hour determinations between 1:00 p. m. and 4:00 p. m. from June to February.

Some of the low photosynthetic values in the writer's experiment were obtained from immature leaves on warm days, when the temperature registered as high as 36° C., or an increase of about 5° C. over the ordinary temperature. Under these conditions, young mango leaves when enclosed in a cellophane chamber showed incipient wilting. This perhaps impaired the functions of the leaves, with the consequent low photosynthetic activities. During the older stages of the leaves, the effect of high temperatures was not so evident, however. In fact high assimilation rates were associated with moderately high temperatures. In this case the increased humidity in the assimilation chamber favored the opening of the stomatas, so that in case the air supply was ample, the relative humidity and temperature were kept at nearly normal amounts, thus favoring appreciable rates of assimilation.

Perhaps one factor that influenced the rate of photosynthesis was the accumulation of by-products (16), (13). This perhaps accounted for the cause of the low values following high rates

in the writer's experiment. Obviously, also, inefficient absorption of $CO_2$ reduced the rate of photosynthesis. In this case, $CO_2$ was the limiting factor(2). See also Brown and Heise(8) and Brown(9). Very likely such limiting factor was at play in the writer's experiment when the leaves approached the wilting point when closure of stomatas was inevitable. Darwin(10) pointed out the relation of closure of stomatas to wilting of leaves. The decrease in the activities of the leaves may be due partly to "time factor" or to fatigue through continuous use Blackman and Matthei(1). In the present studies, the activities of the leaves were generally stimulated after having been rested a few days, that is, the leaves have not been in use due to inclement weather. Low rates were also associated with the color of the leaves. During their purple stage, the leaves showed low or negative assimilation. Perhaps this was partly due to the lack of chlorophyll and also to some other factors. Irving(18) stated that the amount of chlorophyll is not a factor limiting photosynthesis during the early stage of the assimilating organs but some component parts in the photosynthetic machinery that controls it. Evident activities were noted as soon as the leaves have turned light green, but no increase was recorded thereafter, that is, even after the leaves have become dark green. Such trend of photosynthetic activity was also observed by Ilgin(17) and Stiles(24).

The fact that the leaves were enclosed in envelope-chamber, it might be assumed that unless enough air was admitted to supply a nearly normal amount of $CO_2$, the photosynthetic activities have been at levels lower than in the open. Heinicke and Hoffman(14) reported that supplying the air at the rate of 2 to $2\frac{1}{2}$ liters per hour induced normal assimilation. The writer had no way of setting a pre-determined rate of air supply due to lack of appropriate apparatus. The figures obtained under the conditions of the writer's experiment were about one-half lower than those of Heinicke's and Hoffman's.

The higher values of photosynthetic activities in the writer's experiment were registered during days of sunshine alternated by rainy days. This occurred in the months of July and August to early part of September, when the leaves were about $2\frac{1}{2}$ to 3 months old. Perhaps the stimulation in the activities of the leaves was due to the augmented soil moisture which supplied the needs of the plant. Besides being an important factor for photosynthesis, water also induced the opening of stomates(23); Magnes and Furr(19), Dastur(11), Dastur and Desai(12) ob-

served the relation of the degree of turgidity of leaves to the rate of photosynthesis, that is, low water content induces closure of stomatas and consequently retards photosynthesis.

It was also observed that the active period of the mango leaves was characterized by rapid transpiration. The existence of relationship between the rate of transpiration and photosynthesis in the mango seems likely in view of the findings of Ilgin (17), who stated that the transfer of mesophytes to a dry habitat not only induces increased rates of transpiration but also stimulates photosynthesis. It was also observed that the mango assimilated and transpired less during their mature stage. Whether these observations are truly characteristic with the mango or not, it still remains to be proven in the light of further experiments.

While it may be possible to associate the rates of photosynthesis with the prevailing external conditions under which the experiment was conducted, it was difficult to determine exactly the other factor or factors which keep the activities of the leaves at a low level. Neither was it possible to list these factors in the order in which they act upon the plant. Perhaps a thorough experimentation along this line may shed light on this particular point.

## SUMMARY

1. The present paper as reported here constitutes a year's study of the course of assimilation of mango leaves from young stage to maturity. The method employed seems to be satisfactory for comparative studies of the rates of photosynthetic activities during the different stages of the leaves arbitrarily indicated as pre-light green stage, light green stage, and dark green stage, and of the months of the year corresponding to these stages.

2. The leaves showed no photosynthetic activity right after they were formed, or still purple in color. Under these conditions, the first set of leaves showed negative assimilation. But 3 to 5 days after, as the leaves assumed a purplish green color, assimilatory activities were noted. Great activities, however, were not noted until after the leaves were about 15 days old. From this time on, lasting over three months (light green stage), the leaves manifested considerable activities. Then about four months later (dark green stage), until the close of the experiment, irrespective of the presence of favorable conditions, the rates of activities were comparatively low and never reached a maximum comparable to those obtained during the light green

stages of the leaves. It seems that the leaves past the light green stage are no longer active, but for the most part remain as "boarders" until they fall off due to natural incision.

3. Generally, the average assimilations in the morning are greater than those in the afternoon. At least most of the maximum rates were recorded during the morning determinations. It is also apparent that in most cases the fluctuations in assimilation agree with the predominating external factors.

4. This study should lend an aid to the understanding of the value and limitations of the standard cultural practices. Perhaps with the knowledge of the course of photosynthesis with respect to the ages of the leaves or to the time of the year, such cultural practices as pruning, smudging, spraying, or application of fertilizers could be administered to a great advantage. For example, pruning or application of fertilizers may be tried during the different stages of the activities of the leaves. Perhaps experiments along this line with the object in view of improving the yield may prove beneficial to fruit tree culture.

## ACKNOWLEDGMENTS

The writer wishes to express his gratitude to Dr. Vicente C. Aldaba, Chief, Fiber Research Section, for his advice and suggestions during the early part of the work, and later for his help in appraising the results; to Mr. F. G. Galang, Chief, Horticulture Section, for his encouragement during the progress of the work; and lastly to a number of our assistants, particularly Messrs. B. P. Javier and A. C. Pasco for their help in performing the laboratory as well as the field work required by the experiment.

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# ILLUSTRATIONS

PLATE 1. A general view of the apparatus, showing some of its parts.

FIG. A. Assimilation chamber, made of cellophane paper.
FIG. B. Gauge and scales, graduated in liters.
FIG. C. Respiratory tank made of iron.
FIG. D. Table or stand for the respiratory tanks.
FIG. E. Pulley made of wood.
FIG. F. "Arms" made of 12-mm. glass tubings, fitted in a bamboo pole.
FIG. G. Receptacle tank, made of iron. This tank has a capacity more or less the same as that of the respiratory tank.

PLATE 2. A close-up view of the apparatus showing some of its parts in detail.

FIG. A. U-tube for collecting the moisture resulting from transpiration.
FIG. B. Reservoir flask, consisting of 500-cc. Erlenmeyer Pyrex glass, provided with side neck for connections.
FIG. C. Absorption tower, consisting of thick glass tubings, about 60 cm. long and 2.5 cm. in diameter.
FIG. D. Dehydrating bottle of about 100 cc. capacity, containing concentrated sulphuric acid.
FIG. E. Capillary tube.
FIG. F. Home-made mannometer consisting of small glass tubings, about 4-mm. bore, and having U-shapes.
FIG. G. Scale, consisting of a foot rule graduated in centimeters.

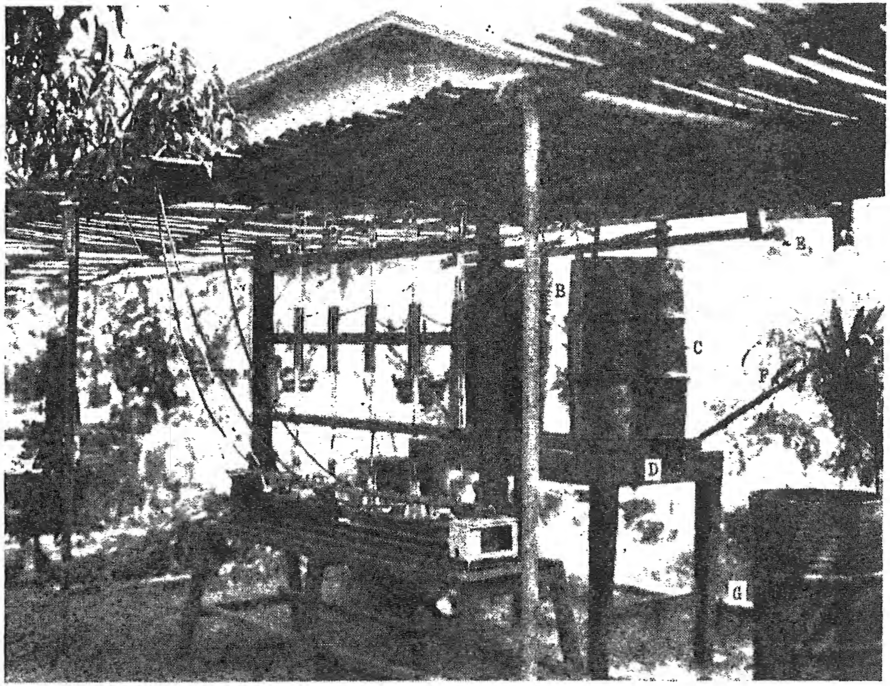


PLATE 1.

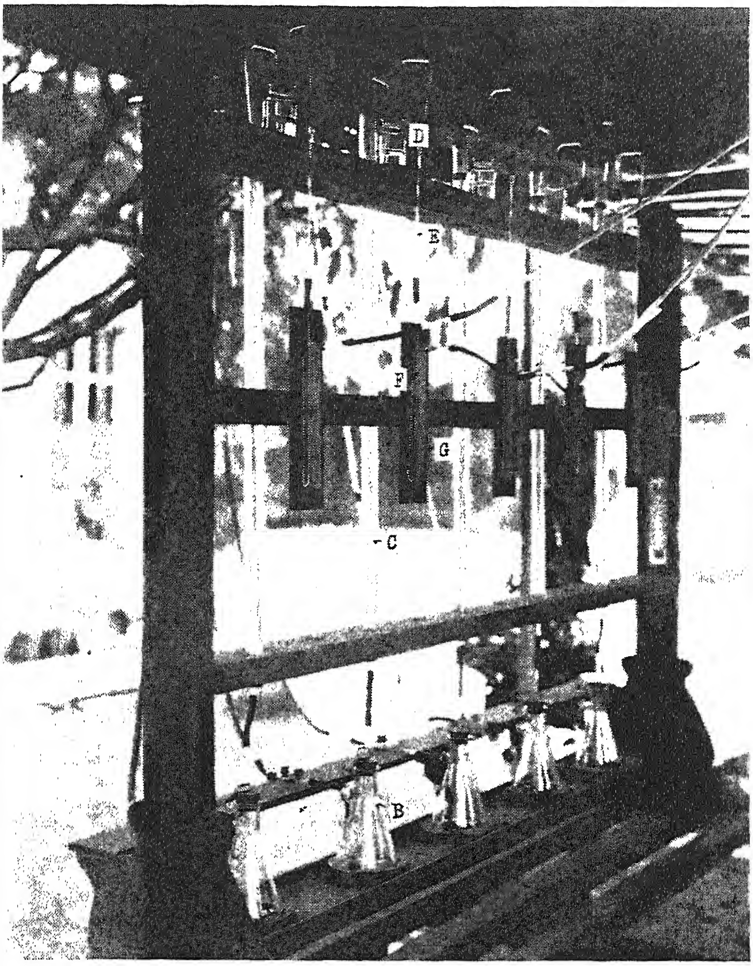


PLATE 2.

# TRIAL PLANTINGS OF IRISH POTATO

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FIVE PLATES

This paper deals with the results of the trial plantings of Irish potato, *Solanum tuberosum* L., at the Lipa Coffee-Citrus Station, Lipa, Batangas Province, from 1933 to 1936, inclusive. The increasing demand for more information on the culture of the Irish potato, especially at medium elevations, and the desire to find new regions suited to its cultivation with the ultimate aim of reducing our half-million-peso annual importation, have encouraged the writers to undertake this study.

The main object of the work is to find the possibility of growing Irish potato at Lipa, a plateau with an elevation of about 1,050 feet above sea level. The other object is to determine whether or not off-season crops of Irish potato could be raised. (The regular season for the culture of Irish potato is from November to February or during the cool months of the year.) Present indications point out that off-season planting is one of the keys to the solution of the local potato seed problem since the harvest of the main crop has been found not to store well for the next regular planting season. As it is now, most of the seed tubers planted are imported. The seed in potato culture, especially when imported, is a big item of expense, and in many cases makes the growing of the crop rather prohibitive.

## MATERIALS AND METHODS

In this study, several varieties of Irish potato purchased from the local market and from abroad were tested. Table 1 shows the varieties tested and the country of origin.

TABLE 1.—*Showing the varieties of Irish potato tested and the country of origin*

| Variety name | Seed house where secured | Country of origin |
|---|---|---|
| Japanese White | Local grocery | Japan. |
| Japanese Red | Local grocery | Japan. |
| Chinese Red | Local grocery | China. |
| Burbank | Local grocery | United States. |
| Oregon | Local grocery | United States. |
| May Queen | Sutton and Sons, Ltd | Great Britain. |
| Ben Lomond | Sutton and Sons, Ltd | Great Britain. |
| Glasgow Favourite | Sutton and Sons, Ltd | Great Britain. |
| Inverness Favourite | Sutton and Sons, Ltd | Great Britain. |
| Commander | Sutton and Sons, Ltd | Great Britain. |
| The Congo | Sutton and Sons, Ltd | Great Britain. |

### DESCRIPTION OF VARIETIES

It is not the aim here to give a botanical description of the different varieties studied. Rather, only the important agronomical characters are given to enable one to recognize a variety more or less readily upon close examination.

*Ben Lomond.*—An English variety. As grown in the Philippines, the haulm is stout but rather spreading, attains a height of about 45 to 60 centimeters, and the foliage is dark green and rather curly. The tubers are round to short kidney in shape with rather shallow eyes (Plate 4, *2*); skin and flesh white; and quality good. The distinguishing characteristic of this variety, however, is its tendency to produce numerous small tubers at every node including those immediately above the surface of the soil.

*Burbank.*—Of United States origin. The plant is characterized by a rather fine haulm although with the tendency to be erect; the foliage is light green. The tubers with distinct markings are elongated with rather shallow eyes, light brown in color with white flesh (Plate 2, *2*).

*Chinese Red.*—This variety matures in 80 to 85 days. The plant is rather dwarf with stout stem. The tuber is more or less round and light red. Very susceptible to soft rot.

*Commander.*—Of English origin. The haulm is of upright habit with semi-drooping foliage which is light green. It has the tendency to have numerous small tubers. The tuber is round to oblong, white, with eyes comparatively shallow.

*Glasgow Favourite.*—From England. The stem is generally erect, and the foliage is light green. The tuber is white-fleshed, and is more or less round to oval, eyes rather shallow (Plate 3, *2*). Fine table quality.

*Inverness Favourite.*—An English variety, and one of the two most promising among those tested. The healthy upright haulm is distinct in appearance; the foliage is dark green; and the white-skinned tubers with shallow eyes are oblong to oval. (Plate 5, *1*.) The tubers keep well in storage, and the cooking quality is excellent.

*Japanese Red.*—Of Japanese origin. A vigorous grower. It matures in 100 to 110 days, the latest to mature among the varieties tested. The haulm is stout and erect; the tubers which are round or spherical are generally borne on long peduncles especially in friable soil. The tuber is light red although the inside is white. Its eating and keeping qualities are poor. Rather deep-eyed.

*Japanese White.*—A Japanese variety which is the most popularly grown in Baguio. The haulm is rather erect but with spreading foliage. The tuber is oval to oblong with rather shallow eyes (Plate 3, *1*). As the name indicates, the skin and flesh are white; the quality is fine.

*May Queen.*—Of English origin and one of the two most productive among those tested. The haulm is comparatively upright but the foliage has the tendency to spread. The tuber is oblong to kidney in shape but is generally thicker on one side. The eyes are shallow, the skin is flesh white, and the appearance is very neat (Plate 2, *1*). The eating and keeping qualities are excellent.

*Oregon.*—Of United States origin. The plant is comparatively vigorous, and the haulm is erect. The tuber is spherical. White-skinned and fleshed, and the eyes are rather shallow (Plate 4, *1*).

*The Congo.*—A salad variety from England. The plant is erect with distinct dark foliage. The nether surface of the leaf is darker than the upper surface, and the veins are more prominently dark. The tubers which are purple flesh, small and much elongated, and the eyes are rather deep and numerous.

## CULTURES

Six sets of planting were made, two sets during the rainy season, and four during the dry season. Table 2 gives the dates of planting and harvesting of the different sets of culture, and also the number of days from planting to harvesting.

TABLE 2.—*Showing the date of planting and harvesting of the different sets of culture*

| Culture | Date plan ed | Date harvested | Number of days to mature |
|---|---|---|---|
| A | December 13, 1933 | March 10–14, 1934 | 86–90 |
| B | August 11, 1934 | October 19–29, 1935 | 69–79 |
| C | January 9, 1935 | April 9–12, 1935 | 90–93 |
| D | June 2, 1935 | August 14–26, 1935 | 73–85 |
| E | November 13, 1935 | February 4, 1936 | 83 |
| F | February 18, 1936 [1] | | |

[1] This culture, because of late planting, was very poor and data on maturity and yield are not included.

In Culture A, seven varieties, namely, Japanese White, Chinese Red, Burbank, Oregon, May Queen, Glasgow Favourite, and Ben Lomond were tested. These were new introductions

and for convenience were called foreign seed tubers. The first generation of the above varieties were used in Culture B. In Culture C, new seed tubers (foreign seed tubers) of Burbank, May Queen, Japanese White, Glasgow Favourite, Commander, Inverness Favourite, Japanese Red, and The Congo, and the second generation of Japanese White, May Queen, Burbank, Glasgow Favourite, Oregon, and Ben Lomond were used. In Culture D, the first and third generations of Oregon and Ben Lomond were used. For Culture E, the second and fourth generations of May Queen, Glasgow Favourite, Burbank, and Japanese White, and second generation of Oregon were used. In Culture F the foreign seed tuber, the second and fourth generations of May Queen, Inverness Favourite, Commander, Glasgow Favourite, and Burbank were tested.

With the exception of Culture A which was conducted between one-year old orchard trees behind the residence of the Superintendent of the Station, all the tests were done in the vegetable experimental field of the Lipa Coffee-Citrus Station. The soil was comparatively shallow, ranging in depth from 30 to 40 centimeters, and was underlaid with adobe soil. It was, nevertheless, fairly uniform, and had a very gentle slope, ensuring good drainage during the rainy season.

In all plantings, the fields were thoroughly prepared with the use of the native plow and harrow. Furrows were made at 80 centimeters apart and the potato seeds were planted singly at 30 centimeters apart in the rows. All the cultures were fertilized with nitrophoska containing 16.5 per cent nitrogen, 16.5 per cent $P_2O_5$, and 20 per cent $K_2O$ (16.5—16.5—20) at the rate of 450 kilograms per hectare. The fertilizer was evenly broadcasted in the furrows and then thoroughly mixed with the soil before planting.

The usual method of planting Irish potato was followed in all plantings. The big tubers were sliced into two or more pieces depending upon their sizes. Those from two to three centimeters in diameter were planted as whole tubers. To minimize any error due to soil variation, the varieties were planted in single rows and were repeated two or more times depending upon the amount of seed tubers available. In each set of planting, the different varieties were given practically the same cultural treatments up to maturity. These treatments consisted of cultivation, weeding, irrigation, spraying, etc.

In all cultures, the weight of the total yield, and that of the marketable tubers of the unit row or plant were taken. Tubers with a diameter of 4 centimeters or more were considered marketable and those below were considered as culls. In Cultures A, B, and E, a single plant was used as the unit in gathering experimental data, while in the rest of the tests (Cultures C and D), the row was considered as the unit.

## EXPERIMENTS AND RESULTS

*Culture A.*—This culture took place from December, 1933, to March, 1934. The season was considered ideal for the growing of potato, and, as a result, a good stand of crop was obtained (see Plate 1, Figs. 1 and 2). Seven varieties were studied in this test. Table 3 presents a summary of the results of this culture.

TABLE 3.—*Showing the comparative yields of seven newly introduced Irish potato varieties at the Lipa Coffee-Citrus Station from December 13, 1933, to March, 1934.*

| Variety name | Generation of seed [1] | Actual yield per plant | | Computed yield per hectare (marketable) |
|---|---|---|---|---|
| | | Total | Marketable | |
| | | *Grams* | *Grams* | *Kilos* |
| May Queen | F | 339.68±5.54 | 329.67±5.48 | 13,738 |
| Glasgow Favourite | F | 222.39±4.46 | 208.60±4.65 | 8,692 |
| Burbank | F | 223.81±3.85 | 208.39±3.63 | 8,650 |
| Japanese White | F | 267.77±4.79 | 259.60±4.77 | 10,817 |
| Oregon | F | 248.90±4.47 | 239.45±4.57 | 9,979 |
| Ben Lomond | F | 358.04±5.56 | 273.88±4.76 | 11,413 |
| Chinese Red | F | 195.35±5.06 | 186.05±5.13 | 7,754 |

[1] F means foreign or introduced seed tubers.

*Culture B.*—This was undertaken during the rainy season of 1934 from August to October. The first generation of the varieties used in the first culture was used with the exception of Chinese Red. Separate plantings of small and big tubers were made. The results show that the big but sliced seed tubers had much lower percentage of germination than the small whole seed tubers. Because of the comparatively excessive rainfall before germination, a high percentage of the sliced tubers failed to germinate. The stand of the crop was, at best, fair. Quite a high percentage of the tubers produced were big enough for planting purposes. Table 4 presents a summary of the results of this phase of the study.

TABLE 4.—*Showing the comparative yields of small and big seed tubers when planted during the rainy season*

| Variety name | Kind of seed tuber | Per cent stand | Average yield per plant | | Computed yield per hectare (marketable) |
|---|---|---|---|---|---|
| | | | Total | Marketable | |
| | | | *Grams* | *Grams* | *Kilos* |
| May Queen | big | 54 | 185.15±11.57 | 168.82±11.52 | 3,798 |
| May Queen | small | 74 | 197.44± 8.79 | 111.70± 5.21 | 3,444 |
| Glasgow Favourite | big | 14 | 136.70±15.64 | 106.60±14.20 | 622 |
| Glasgow Favourite | small | 59 | 145.39± 6.93 | 69.37± 4.33 | 1,706 |
| Burbank | big | 59 | 158.12± 7.04 | 144.85± 7.24 | 3,562 |
| Burbank | small | 72 | 127.52± 5.21 | 113.74± 5.02 | 3,418 |
| Japanese White | big | 20 | 240.23±19.64 | 221.86±18.64 | 1,849 |
| Japanese White | small | 35 | 167.30± 9.46 | 150.46±10.45 | 2,191 |
| Oregon | big | 32 | 152.00±10.03 | 139.75± 9.46 | 1,864 |
| Oregon | small | 77 | 189.74± 7.11 | 175.96± 7.16 | 5,864 |
| Ben Lomond | big | 51 | 197.39±11.44 | 128.02± 8.80 | 2,720 |
| Ben Lomond | small | 61 | 233.60± 8.21 | 154.54± 8.21 | 3,927 |

*Culture C.*—The results of this culture are presented in Table 5. The culture was undertaken from January, 1935, to April of the same year. The planting was rather late, and the crop was confronted with the effects of the dry season. The strong dry wind then prevalent greatly affected this culture. The stand of the crop was very poor compared with that of the previous year (Culture A). In this culture, an attempt was made to compare the yielding ability of the Lipa grown seed tuber (second generation) and the imported seed tuber. Newly imported varieties were also included in the cultures.

TABLE 5.—*Showing the compartive yields of Lipa grown and imported seed tuber (dry season culture)*

| Variety name | Generation of seed tuber [1] | Actual yield of 18-sq m. plots | | Computed yield per hectare (marketable) |
|---|---|---|---|---|
| | | Total | Marketable | |
| | | *Kilos* | *Kilos* | *Kilos* |
| May Queen | $F_2$ | 4.91±0.45 | 4.43±0.46 | 2,494 |
| May Queen | F | 6.11±0.44 | 5.75±0.44 | 3,237 |
| Glasgow Favourite | $F_2$ | 3.70±0.32 | 2.80±0.17 | 1,577 |
| Glasgow Favourite | F | 7.60±0.54 | 7.19±0.53 | 4,049 |
| Burbank | $F_2$ | 4.97±0.41 | 4.44±0.39 | 2,500 |
| Burbank | F | 6.17±0.42 | 5.76±0.41 | 3,243 |
| Japanese White | $F_2$ | 2.24±0.06 | 2.02±0.30 | 1,137 |
| Japanese White | F | 4.26±0.15 | 4.03±0.15 | 2,269 |
| Oregon | $F_2$ | 2.52±0.27 | 2.38±0.28 | 1,340 |
| Ben Lomond | $F_2$ | 4.74±0.17 | 2.79±0.95 | 1,571 |
| Commander | F | 6.58±0.69 | 5.43±0.69 | 3,057 |
| Japanese Red | F | 3.88±0.38 | 3.68±0.36 | 2,072 |
| Inverness Favourite | F | 9.18±0.49 | 8.60±0.46 | 4,843 |
| The Congo | F | 2.24±0.24 | 1.95±0.24 | 1,098 |

[1] $F_1$ means foreign or introduced seed tubers. $F_2$ means second generation.

*Culture D.*—This culture took place during the rainy season of 1935 from June to September. Ten varieties were included in the test. The seed tubers used were Lipa grown and they represented first and third generations of several varieties. Small and big seed tubers were again compared. Table 6 gives a summary of the results obtained. As in a previous rainy season test, the sliced seed tubers had very poor percentage of germination. Many plants died because of the severe attack of Solanaceous wilt.

TABLE 6.—*Showing the comparative yields of small and big seed tubers of first and third generations*

| Variety name | Generation of seed tuber [1] | Big seed tuber (sliced) | | Small seed tuber (whole) | |
|---|---|---|---|---|---|
| | | Number of hills planted | Average yield per plant (marketable) | Number of hills planted | Average yield per plant (marketable) |
| | | | *Grams* | | *Grams* |
| May Queen | $F_1$ | 8 | 73.0 | 57 | 132 |
| May Queen | $F_3$ | 27 | 150 | 50 | 154 |
| Glasgow Favourite | $F_1$ | 0 | Few germinated. | 24 | 109 |
| Glasgow Favourite | $F_3$ | 0 | Few germinated. | 17 | 79 |
| Burbank | $F_1$ | 0 | Few germinated. | 2 | 128 |
| Burbank | $F_3$ | 0 | Few germinated. | 10 | 48 |
| Japanese White | $F_1$ | 0 | Few germinated. | 5 | 73 |
| Japanese White | $F_3$ | 0 | Few germinated. | 4 | 156 |
| Oregon | $F_3$ | 2 | 120 | 5 | 247 |
| Ben Lomond | $F_3$ | 0 | Few germinated. | 7 | 92 |
| Inverness Favourite | $F_1$ | 0 | Few germinated. | 47 | 140 |
| Commander | $F_1$ | 5 | 106 | 49 | 159 |
| The Congo | $F_1$ | 0 | Few germinated. | 4 | 48 |
| Japanese Red | $F_1$ | 0 | Few germinated. | 0 | Few germinated |

[1] $F_1$ means first generation, and $F_3$ refers to third generation.

TABLE 7.—*Showing the comparative yields of second and fourth generations of different varieties of Irish potato*

| Variety name | Generation of seed tuber [2] | Average yield of 13-sq. m. plot | | Computed yield per hectare (marketable) |
|---|---|---|---|---|
| | | Total | Marketable | |
| | | *Kilos* | *Kilos* | *Kilos* |
| May Queen | $F_2$ | 10.44±0.34 | 9.68±0.29 | 7,446 |
| May Queen | $F_4$ | 10.94±0.39 | 10.22±0.36 | 7,862 |
| Burbank | $F_2$ | 4.91±0.46 | 4.37±0.48 | 3,362 |
| Burbank | $F_4$ | 4.31±0.07 | 3.95±0.24 | 3,038 |
| Glasgow Favourite | $F_2$ | 7.64±0.39 | 6.91±0.36 | 5,315 |
| Inverness Favourite | $F_2$ | 13.44±0.30 | 12.59±0.27 | 9,685 |
| Commander | $F_2$ | 10.67±0.28 | 5.06±0.28 | 3,892 |
| The Congo | $F_2$ | 1.86±0.48 | 1.24±0.36 | 954 |
| Japanese White [1] | $F_4$ | 2.80 | 2.36 | 1,815 |
| Oregon [1] | $F_4$ | 2.88 | 2.60 | 2,000 |

[1] Because of the lack of seed tuber only one replication was made.

[2] $F_2$ means second generation and $F_4$ refers to fourth generation.

*Culture E.*—This culture was one of the best in stand and in yield in the whole series. The culture was held from November, 1935, to February, 1936. Eight varieties were included in the test and, besides comparing the yielding ability of the different varieties, an attempt was also made to compare the productivity of the second and fourth generations of seed tubers. Tables 7 and 8 present the summary of the results of this study.

TABLE 8.—*Showing the comparative yields of small and big seed tubers of four varieties of Irish potato*

| Variety name | Kind of seed tuber | Average yield of 13-sq. m. plot (marketable) | Computed yield per hectare |
|---|---|---|---|
| | | *Kilos* | *Kilos* |
| May Queen | Big | 11.06 ±0.18 | 8,508 |
| May Queen | Small | 9.72 ±0.12 | 7,477 |
| Burbank | Big | 4.06 ±0.32 | 3.123 |
| Burbank | Small | 5.11 ±0.12 | 3,931 |
| Inverness Favourite | Big | 12.70 ±0.54 | 9,769 |
| Inverness Favourite | Small | 12.49 ±0.47 | 9,615 |
| Commander | Big | 4.70 ±0.37 | 3,923 |
| Commander | Small | 5.42 ±0.36 | 4,169 |

*Culture F.*—In this culture, an attempt was again made to compare the yielding powers of Lipa grown potato seed tuber (second and fourth generations) and the imported seed tuber. Due to the delayed arrival of the foreign seed tuber, the culture was started during the early part of February, 1936. As a result, the stand of the crop was very poor because of dryness and the prevalence of dry wind. It was deemed necessary, therefore, not to include in this report the data obtained.

TABLE 9.—*Comparative yields of different varieties of Irish potato for a period of three years*

| Variety name | Average yield per hectare (dry season culture) | | | |
|---|---|---|---|---|
| | 1933–34 | 1934–35 | 1935–36 | Average |
| | *Kilos* | *Kilos* | *Kilos* | *Kilos* |
| May Queen | 13,738 | 2,866 | 7,659 | 8,088 |
| Glasgow Favourite | 8,692 | 2,813 | 5,315 | 5,607 |
| Burbank | 8,650 | 2,872 | 3,200 | 4,907 |
| Japanese White | 10.817 | 1,703 | 1,815 | 4,778 |
| Oregon | 9,979 | 1,340 | 2,000 | 4,440 |
| Ben Lomond | 11,413 | 1,571 | ---------- | 6,492 |
| Chinese Red | 7,754 | ---------- | ---------- | 7,754 |
| Commander | ---------- | 3,057 | 3,892 | 3,475 |
| Japanese Red | ---------- | 2,072 | ---------- | 2,072 |
| Inverness Favourite | ---------- | 4,843 | 9,685 | 7,264 |
| The Congo | ---------- | 1,098 | 954 | 1,026 |

Table 9 was prepared so as to have an idea of the average yielding power of the different varieties tested during the regular planting season (dry season). This table is a summary of Tables 3, 5, and 7.

## DISCUSSION OF RESULTS

Some definite information on the possibility of growing Irish potato at the Lipa Coffee-Citrus Station and its vicinity have been obtained. In general, dry season plantings showed some possibilities for the commercial growing of Irish potato in that region. Rainy season cultures were full of risk because of uncertain weather conditions but when the planting was made at a time that was not followed by a continuous rain, it also showed some possibilities for the production of good-sized tubers for planting purposes during the regular planting season which, in Lipa and its vicinity, is from November to early part of January.

### VARIETIES TESTED

As seen in Table 1, eleven varieties of Irish potato, six from Great Britain, two from the United States, two from Japan, and one from China, were tested in connection with this study. These varieties were tested for a period from one to three years. The average computed yield per hectare of the dry season cultures of these varieties is summarized in Table 9. A study of Table 9 shows that May Queen and Inverness Favourite were the most productive and, therefore, seem to be the best adapted to Lipa conditions among the eleven varieties studied. The average yield of May Queen was 8,088 kilograms per hectare for a period of three years, and it ranged from 2,866 kilograms in 1934–35 when the planting was late to 13,738 kilograms per hectare in 1933–34 when the planting was made in December and conditions were more favorable. The average yield of Inverness Favourite was 7,264 kilograms per hectare for a period of two years and the range varied from 4,843 to 9,685 kilograms per hectare. It is interesting to note that during the last two years when these two varieties were cultured together, Inverness Favourite outyielded May Queen (see Table 9). Both of these varieties have attractive appearance and good storing quality (see Plate 2, fig. 1 and Plate 5, fig. 1). Their eating qualities are also excellent. They mature in 85 to 100 days depending upon the season of the year at the time of planting.

Of the less productive but nevertheless promising varieties may be mentioned Glasgow Favourite with an average yield of

5,607 kilograms per hectare; Burbank, with a three-year average yield of 4,907 kilograms per hectare; Japanese White, with a three-year average yield of 4,778 kilograms per hectare; and Commander, with a two-year average yield of 3,475 kilograms per hectare. The Commander variety, while it has a lower average yield than either Burbank and Japanese White (see Table 9), has an average yield during the last two years greater than those of either Burbank and Japanese White.

It may also be noted in Table 9 that Chinese Red and Ben Lomond had comparatively high yields—higher than anyone of those considered promising varieties. It may be stated here, however, that Chinese Red was tested for only one year (Culture A) and it was the poorest in that test. Its storing quality was also the worst. Ben Lomond, on the other hand, while it was the second best in yield in 1933–34, did not produce well in the succeeding years. Besides, it showed an undesirable characteristic—the production of small and numerous tubers at every node, including those immediately above the soil. The Congo, because of the small size of the tubers, is naturally a poor yielder. Under local conditions where there is no demand yet for varieties especially adapted to salad making, the The Congo, because of its very low yield and poor keeping quality, has no prospect.

### SMALL VERSUS BIG TUBERS FOR SEED

An attempt was made to find the value of small tubers (20 to 35 grams in weight) and big tubers for planting purposes. Tables 4 and 8 present the results of the tests. A study of both tables will show that the yielding power of small and big tubers varied with the different varieties. As seen in Table 4, four of the six varieties tested showed that the big tubers yielded more than the small tubers although in one case the difference was not significant. In the case of Oregon and Ben Lomond, the small seed tubers produced more than the big seed tubers, but it was only in the case of the first variety where the difference may be considered mathematically significant.

In the dry season culture (see Table 8) the big seed tubers yielded more in the case of May Queen and Inverness Favourite, but less in the case of Burbank and Commander. The differences, however, were not significant except in the case of Burbank. From present appearances it seems that the size of the seed tubers (within certain limit) does not materially affect the yielding power of the plants produced. The results, in general,

tend to corroborate the findings of Hutcheson and Wolfe[1] who reported that 1-ounce (28.3 grams) "cuts" had practically the same yield whether such "cuts" were either sliced or small (whole) seed tubers. It seems that the more important consideration is the vitality of the seed tuber when planted.

### RAINY SEASON TEST

The percentage of the stand of the crop during the rainy season was rather low, especially in the case of the big but sliced seed tubers. The stand of the crop from the big but sliced seed tubers varied from 14 to 59 per cent among the six varieties tested, while in the case of the small (whole) seed tubers, the stand varied from 35 to 77 per cent. It was evident that under wet soil conditions, the sliced seed tubers were more subject to rotting than the whole tubers, thus resulting in lower percentage of germination and poorer stand of the crop.

The tubers produced during the rainy season tests were small as compared with those produced during the dry season (see Plate 5, fig. 2). They were, however, big enough for seed purposes. As seen in Table 4, the computed yield per hectare of the four best varieties varied from 1,864 to 5,864 kilograms. These yields are rather low as compared with those of the dry season cultures. The results, nevertheless, point out the possibility of growing Irish potato during the rainy season to supply the seed tuber for the main crop in November to early part of January.

It should be remarked in here that in connection with Irish potato culture in the Islands, the question of seed tuber is one, if not the most important limiting factor of production. This is especially so when the seed tuber is purchased. However, as aided by favorable market conditions its culture here may be made more profitable if the seed tuber is produced by every grower.

As already stated, the main handicap in growing potato during the rainy season is the rather poor stand of the crop due to low percentage of germination, and in some cases, its total failure because of unforeseen inclement weather. This disadvantage, however, may be minimized by setting the seed tubers at the proper time, that is, to plant when heavy and continuous rains are not likely to occur. If the seed tubers are set in when the soil is not liable to be soaked, the germination would be high.

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[1] Hutcheson, T. B., and T. K. Wolfe. Potato culture. Virginia Agric. Expt. Sta. Bull. No. 217 (1917).

From experience, one can more or less tell the best time to set in seeds in a certain locality. In Lipa, at least, potato may be safely planted during May or the early part of June and in the early part of August. Planting in May and June seems to be about the best because of the fact that potato planted at this time can be harvested a few months before the regular planting season in November and December, thus giving the new harvest enough time to be seasoned out or cured before they are planted. It may be mentioned here that newly harvested tubers do not germinate readily when planted; it takes from two to three months after harvest before the tubers attain normal germination. August planting seems to be rather late.

## PHILIPPINE GROWN VERSUS IMPORTED SEED TUBER

In the 1934–35 and 1935–36 dry season cultures, an attempt was made to compare the yielding power of the Lipa grown seed tuber and imported seed tuber. Results of the first test are presented in Table 5; in the second test due to late planting because of the delayed arrival of the foreign seed, the culture was a failure. A study of Table 5 shows that of the four varieties tested, namely, May Queen, Glasgow Favourite, Burbank, and Japanese White, the imported seed tuber was decidedly superior in yielding power to the Lipa grown seed tuber. It may be stated in this connection that judging from appearances, the imported seed tubers were newer and more vigorous than the Lipa grown seed tuber, and as a result, the stand of the plants was better in the plots planted with the former seed. However, it may also be mentioned that in the 1935–36 dry season culture of Lipa grown seed, the stand of plants and the yield thereof were comparable to those of the 1933–34 culture of imported seed (see Tables 3 and 7). This goes to show that wherever possible, it would seem more economical to raise the potato seed tuber locally.

## SUMMARY AND CONCLUSIONS

From the results presented in this paper, the following conclusions seem to be justified:

1. The conditions of Lipa, Batangas (the elevation is 1,050 feet above sea level), have been found to be adapted to the growing of Irish potato. The yield per hectare of a number of varieties tested varied from 954 to 13,738 kilograms. With the four best varieties, the yield varied from 2,813 kilograms per hectare during the lean years to 13,738 kilograms during good years.

2. Of the eleven varieties tested for a period of two to three years, May Queen and Inverness Favourite were the two most productive varieties, the average yield being 8,088 and 7,264 kilograms per hectare, respectively. The less productive, but nevertheless, promising varieties were Glasgow Favourite, Japanese White, Burbank, and Commander.

3. Based on the performance of the two best yielding varieties (May Queen and Inverness Favourite) the months of November and December have been found to be the best time to plant Irish potato at the Lipa Plateau. In the 1933–34 season, the sowing was made in December and the yield of May Queen was 13,738 kilograms per hectare; in 1934–35 the planting was made in November and the respective yields of the two above mentioned varieties were 7,659 and 9,685 kilograms per hectare.

4. While the results for two years on the comparative study of the value of small (whole) seed tubers (20 to 35 grams in weight) and sliced big tubers (above 35 grms. in weight) were in favor of the big seed tubers, the difference was not very significant. However, during the rainy season tests, the small seed tubers (planted whole) had a decided advantage over the big seed tubers (sliced) as they were less subject to decay.

5. Rainy season cultures did not behave as well as the dry season cultures. The general stand of the crops both in percentage and in appearance was much inferior to that of the dry season cultures. The seed tubers planted were subject to decay before germination, especially when the soil was soaked soon after planting. However, when the seed tubers were able to germinate before the continuous rain came, the behaviour of the crop was better. Some varieties gave yields as high as from 3,444 to 5,864 kilograms per hectare during the rainy season test. The tubers produced were comparatively small but were large enough for seed purposes.

6. In a study where Lipa grown seed tuber was compared with imported seed tuber in yielding quality, it was found that the imported seed tuber was decidedly better than the local grown seed tuber. It is significant to note, however, that the second and fourth generations of seed tubers planted in November, 1935, gave comparable yields to the imported seed tubers planted in 1933–34.

# ILLUSTRATIONS

PLATE 1

FIG. 1. Showing the first trial planting of some United States, Japanese and Chinese varieties of Irish potato at the Lipa Coffee-Citrus Station. Note the excellent growth of the vines.

2. Showing the first trial planting of some varieties of Irish potato from Sutton's and Sons Co. Ltd., Reading, England at the Lipa Coffee-Citrus Station. Note the luxuriant growth of the vines.

PLATE 2

FIG. 1. Typical tubers of variety May Queen. Note the shallow "eyes"; the tuber is elongated but more or less flat on one side. Three-fourths natural size.

2. Typical tubers of Burbank as grown in the Philippines showing the characteristic markings. Three-fourths natural size.

PLATE 3

FIG. 1. Typical tubers of Japanese White, natural size.

2. Typical tubers of Glasgow Favourite, natural size.

PLATE 4

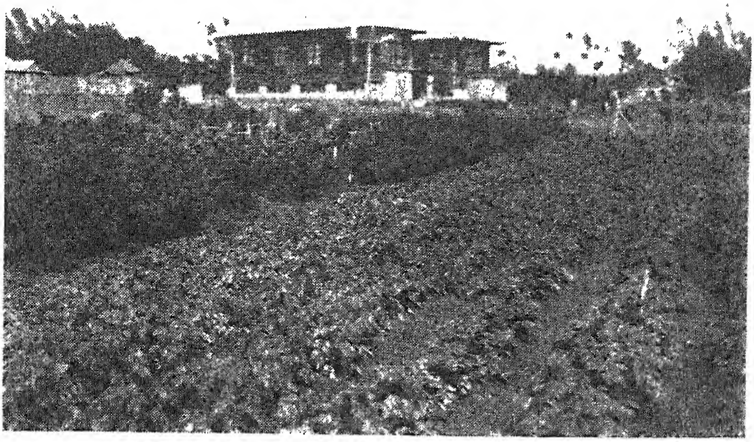
FIG. 1. Tubers of Variety Oregon. Spherical in shape with shallow "eyes". Natural size.

2. Typical tubers of Ben Lomond, natural size.

PLATE 5

FIG. 1. Typical tubers of Inverness Favourite, natural size.

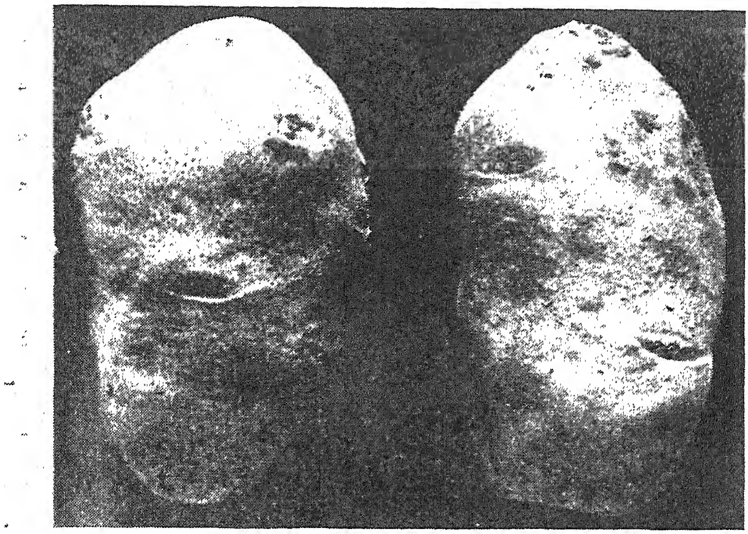
2. Tubers of Invernes Favourite (three-fourths natural size) as grown during the rainy season at the Lipa Coffee-Citrus Station. Quite small but large enough for seed purposes during the regular planting season (November to December).



1

2

PLATE 1.



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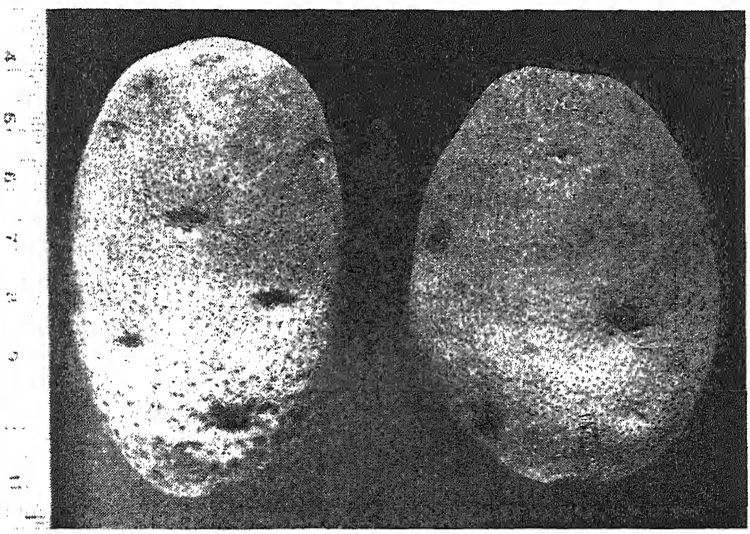
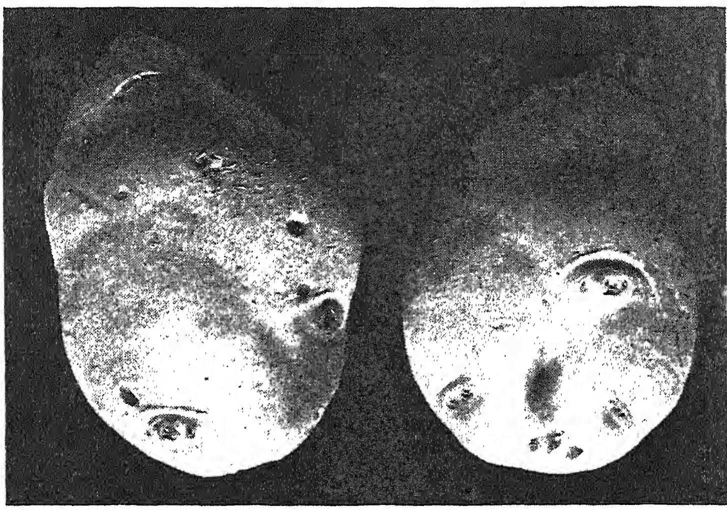


2

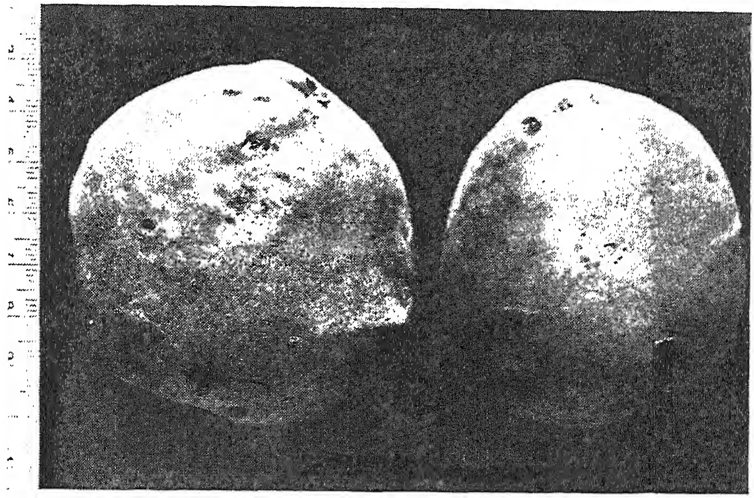
PLATE 2.

*1*



*2*

PLATE 3.



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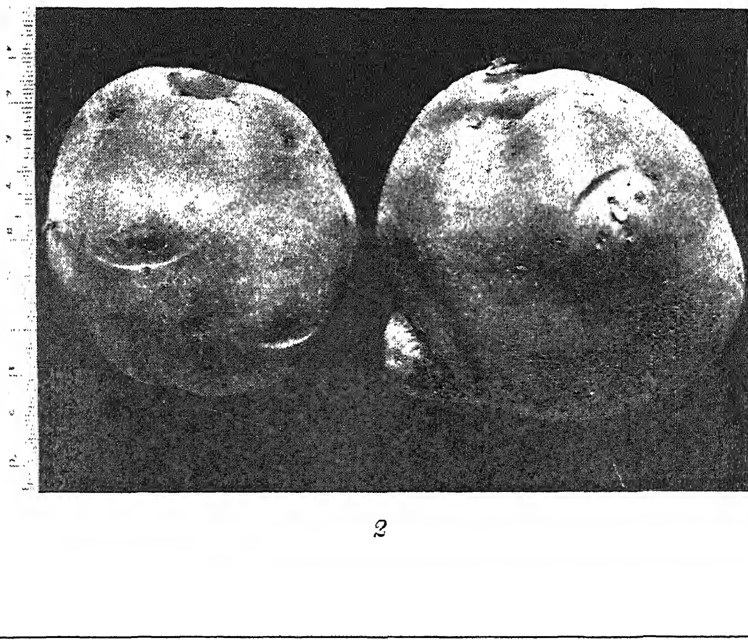

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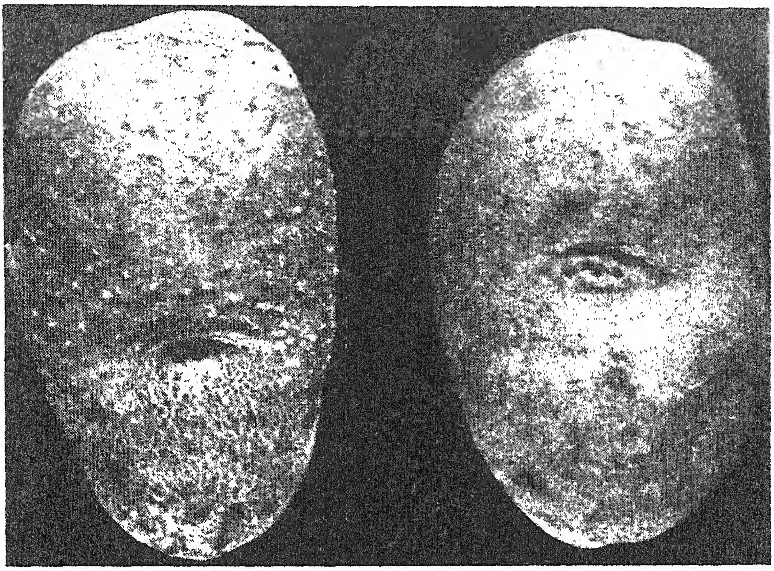
PLATE 4.



1

2

PLATE 5.

# THE TOMATO LEAFMOLD (*CLADOSPORIUM FULVUM* CKE.), A NEW SERIOUS DISEASE OF TOMATO IN BAGUIO, MOUNTAIN PROVINCE

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*Of the Bureau of Plant Industry*

TWELVE PLATES

## INTRODUCTION

The tomato leafmold, *C. fulvum* Cke., which is a serious leaf disease of glasshouse-grown tomatoes in the United States and in other temperate countries was noted for the first time in Baguio,[2] Mountain Province, in 1934. It appeared in the glasshouse of the Baguio Plant Industry Experiment Station on both American and native tomatoes toward the end of the fruiting season when few plants showed the typical lesions, which resulted in the yellowing, curling, or drying up and falling of the leaves. The following season, the disease became more general and affected the plants in their early stages. Those which were severely attacked were stunted, or died prematurely, while those that were able to survive lost almost one-half to three-fourths of their leaves, so that their yield was greatly reduced, and the fruiting season very much shortened.

Because of the scarcity and high price of tomatoes, especially during the rainy season, the culture of this crop commercially under glasshouses might prove to be a profitable enterprise in Baguio and in other parts of the Philippines with identical climate. Since the leafmold disease is likely to become an important disease of tomatoes grown under glasshouses, and in the field as will be discussed later, a preliminary report of our observations of the disease are hereby presented for the interest

[1] The writer is grateful to Lt. Juan P. Tecson, who was formerly with this Bureau, for his assistance in some observations herein reported in this paper.

[2] Baguio has an elevation of over 4,000 feet above sea level and the climate is generally uniformly cool throughout the year. Because of this favorable semi-temperate climate, extensive culture of vegetables are grown from which several thousand pesos are ralized every year.

of prospective glasshouse tomato growers particularly in the vicinities of Baguio.

### GEOGRAPHIC DISTRIBUTION AND ECONOMIC IMPORTANCE

In the United States (1), (5), (6), (7), (10), (11), (16), (17), and other temperate countries (2), (3), (8), (9), (12), (13), the leafmold disease is well known. It is generally serious on tomatoes in glasshouses in the northern States which are not provided with adequate heating and ventilating system, while in Florida (16) and other sections of the southern States it is regarded primarily as a field disease of tomato. In the Philippines, this malady was observed in Baguio, and under certain conditions it becomes very serious in the glasshouse[3] (Plate 1) and in the field.

The annual loss due to it has not been actually determined, but during the rainy or cooler and moister months it becomes epiphytotic and spreads rapidly in the glasshouse, causing within a few days many leaves to turn yellow and fall off. Because of the loss of the leaves, which results into a greatly weakened condition of the plants, the yield is materially reduced due to failure of some fruits from reaching their normal size, or failure of the fruits from becoming set. If the infection is severe when the plants are young, such plants may be stunted or die prematurely, and if infection occurs when the plants are already full grown or have already fruited, slight to no reduction of yield may be noted.

The writer is not aware just how this disease got into the Philippines; but since it is known to be seed borne (5), it is probable that it might have been introduced with the infected seeds, and since it was not observed during the survey of garden crop diseases in this region (4), it is also believed that its introduction into this region is very recent.

### GENERAL SYMPTOMS

The tomato is susceptible to the disease at any stage of growth and the leaves, flowers, fruits, and even the succulent stems are attacked. The greatest damage, however, occurs on the leaves where infection usually starts on the lower ones close to the ground and then gradually spreads upward until one-half

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[3] The glasshouse at the Experiment Station has a glass roof and glass sides, but it is not provided with mechanical devices with which to regulate the heat and humidity as is found in modern glasshouses in temperate countries.

to nearly all are affected. Later on, these affected leaves turn yellow, dry up and finally drop off (Plates 2 and 3), or dry up and curl rapidly but remain attached to the stem so that these infected plants appear as if they were swept by fire.

The lesions on the leaves usually start as a small whitish downy patch of fungus growth on the lower surface (Plate 4, fig. 1 and Plate 6, fig. 2). Under favorable conditions, as this downy patch enlarges the advancing edge retains its whitish color, while the center becomes light brown to dark velvety brown due to the production of abundant spores of the causal organism (Plate 4, fig. 3 and Plate 5, figs. 1 and 2). On the upper surface of the leaves opposite this fungus growth, the tissues become light green to yellowish green color (Plate 4, fig. 2 and Plate 6, fig. 1), and from these areas the spores of the fungus may be also produced (Plate 4, fig. 2). These yellowish green tissues also increase in size as larger areas become invaded by the fungus and sooner or later such tissues die and form dark brown dead spots of varying sizes and shapes, sometimes involving the whole leaf area (Plate 4, fig. 2 and Plate 6, fig. 1).

The flowers and fruits are also attacked by the disease (5) and (6). On the flowers, the calyx as well as the other parts are also affected, with the production of dark velvety growth of the causal fungus. Because of this infection, the flowers sooner or later die and fall off before the fruits are set. Examination of infection on the flowers, however, should be carefully made so that the effect of such infection would not be confused with that produced by other organisms such as tiny bugs. The symptoms on the fruits are very characteristic, and according to Gardner(5) it causes conspicuous black stem end rot of both immature and ripe greenhouse tomatoes.

## CAUSAL ORGANISM

The causal fungus is a member of the Dematiaceæ, of the large group of fungi—Fungi imperfectii. The mycelium and the fruit bodies are colored. The conidia are elliptical to oblong, 1 to 2 septate, and are borne on the tip of the conidiophores. According to Stevens(14) they vary in sizes from 10 to 20 by 4.0 to 6.0 microns, but from our measurements, they are from 12.9 to 27.2 by 6.8 to 11.2 microns, showing that the spores of the species here reported are slightly bigger but are closely within the range of sizes given by Stevens. The conidiophores are sparingly branched, septate, and arise at the stomatal opening of the leaves. They are from 54.4 to 204.0 by 3.4 to 8.5

microns. Plate 7 shows the spores and conidiophores of *C. fulvum* Cke., from diseased tomato leaf from the glasshouse.

### GERMINATION OF SPORES

The spores do not readily germinate under dry conditions, but in the presence of sufficient moisture they germinate within a few hours in the glasshouse, in the laboratory, or in the open under shade. In a series of experiments conducted during September, sample of spores suspended in 5 cc. of tap water, or in 5 cc. of 2 per cent sugar solution gave 89.4 and 98.5 per cent germination, respectively, after 24 hours. In these experiments, a hanging drop from each of these germinating solutions with spores was placed in a series of van Tieghem cells, and then exposed for 24 hours under laboratory conditions in Baguio with temperatures ranging from 17° to 22° C. In order to keep them moist, the slides were placed in moist petri dishes, the bottom of which were covered with two layers of moist filter papers.

TABLE 1.—*Germination of C. fulvum spores under various conditions in Baguio*

| Environment under which the spores were allowed to germinate | Duration of observation [a] | Per cent germination | Length of germ tubes in microns | |
|---|---|---|---|---|
| | | | Range | Average |
| | *Hours* | | | |
| Laboratory conditions | 4 | 21.6 | 3.4–15.3 | 9.6 |
| | 8 | 87.0 | 10.2–34.0 | 19.5 |
| | 12 | 94.4 | 37.4–68.0 | 50.5 |
| 17°—20° C. | 24 | 97.3 | 40.8–105.4 | 65.7 |
| | 30 | | ([b]) | ([b]) |
| Average—18.5° C. | | | | |
| Glasshouse conditions | 4 | 23.5 | 3.5–23.8 | 9.5 |
| | 8 | 82.2 | 6.8–51.0 | 27.5 |
| | 12 | 89.8 | 10.2–61.0 | 35.1 |
| 17°–22 C. | 24 | 92.8 | 40.8–112.0 | 72.9 |
| | 30 | | ([b]) | ([b]) |
| Average—20° C. | | | | |
| Outside conditions | 4 | 4.9 | 3.4–6.8 | 5.1 |
| | 8 | 16.3 | 3.4–17.0 | 7.6 |
| | 12 | 16.6 | 6.8–20.4 | 12.2 |
| 16°–20° C. | 24 | 86.8 | 20.4–71.4 | 39.4 |
| Average 17.5° C. | 30 | 93.3 | 20.4–80.2 | 44.1 |

[a] At the time this experiment was conducted, it was generally cloudy in the morning, rainy at noon until afternoon, and foggy at night.

[b] Branching profusely after 30 hours.

Using identical methods as above, another series was conducted, with 2 per cent sugar solution used as the germinating medium. Series of hanging drops in van Tieghem cells were made and exposed in the laboratory, in the glasshouse, and in the shade outside. The results which are summarized in Table 1 show that germination took place even after 4 hours, and 24 hours later the percentage of germination from all these sets of conditions was high. In this study it was also observed that the rate of germination and the elongation of germ tubes of those kept in the laboratory and in the glasshouse was much faster than those left in the open under shade.

The results obtained show that the spores germinated readily under these sets of conditions in Baguio with temperatures ranging from 16° to 27° C., and are in accord with the results of Gardner(5) and Makemson who found that spore germination in water is best at temperatures between 18° to 24° C., a similar range of temperature generally found in Baguio. Plate 7 shows the germinating spores of *C. fulvum* Cke., after 4, 8, 12, and 24 hours.

## LONGEVITY OF SPORES

The spores are known to remain viable for a few months to one year(5) and (10). In a series of experiments, spores were scraped off from fresh infected leaves, then put in petri dishes, and were allowed to desiccate in the glasshouse and in the laboratory for 15, 20, 30, and 45 days. After each time interval, sample of spores were suspended in 2 per cent sugar solution and the percentage of germination was determined after 48 hours. As shown in Table 2 the percentage of germination was greatly reduced after 45 days. This result was further confirmed by another series of experiments in which infected leaves with heavy sporulations were desiccated in the glasshouse and in the laboratory as mentioned above, showing that the spores are still viable after 45 days, the longest period tried. No attempt was made to determine how long the spores would survive, but because of the ideal semi-temperate climate of Baguio (Table 3) and from what is already known on the viability of the spores, they might live long enough in our glasshouse to cause infection from one tomato season to the next, as will be discussed herein.

TABLE 2.—*Longevity of spores of C. fulvum Cke. in the glasshouse and in the laboratory in Baguio*

| Duration of dessication | Glasshouse conditions | | Laboratory conditions | |
|---|---|---|---|---|
| | Number of pores observed | Percent germination after 48 hours | Number of pores observed | Percent germination after 48 hours |
| *Series I* [a] | | | | |
| 20 days | 150 | 83.6 | 105 | 85.6 |
| 30 days | 105 | 25.7 | 125 | 15.1 |
| 45 days | 347 | 18.3 | 172 | 41.8 |
| Check [c] | | | 100 | 51.0 |
| *Series II* [b] | | | | |
| 20 days | 207 | 51.2 | 99 | 26.2 |
| 30 days | 334 | 13.1 | 126 | 5.1 |
| 45 days | 565 | 4.9 | 235 | 1.3 |
| Check [c] | | | 269 | 43.9 |

[a] Spores were scraped off the leaves and placed in petri dishes.
[b] Infected leaves with heavy sporulations were placed in petri dishes.
[c] Spores were obtained from fresh diseased leaves of growing tomato plants in the glasshouse.

## INFECTION EXPERIMENTS

In a series of experiments, 6 potted young tomato plants were inoculated by applying spores in suspension on both sides of the leaves by means of an atomizer. After inoculation, the plants were placed in an improvished moist chamber for 24 hours, and then placed in the glasshouse, in the shade outside, and in the open without shade, by placing two plants to each set of conditions. After 10 days, infection was noted on the plants left in the glasshouse, while those left outside developed their symptoms after 15 days. In another set, six plants were again inoculated, but after inoculation they were placed in the open without shade and in the glasshouse. After 20 days, all became infected and the disease was noted to have already spread to the younger upper leaves (Plate 8).

In the last series, two healthy plants growing outside near the laboratory and six plants in the glasshouse were inoculated on September 19, 1936, and one plant growing in the field was inoculated on September 28. Again, all these plants became infected after two weeks. The infected plants in the glasshouse were then transplanted in the field. These, together with the other plants outside, continued to be infected when the final notes were made in December. The result of these ex-

periments showed that the tomato plants growing in the field or glasshouse became readily infected with the leafmold disease, but the lesions which developed on plants left in the glasshouse were more extensive and with heavier sporulations than from those observed from the field at this time of the year when these studies were made.

### SEASONAL OCCURRENCE OF THE DISEASE IN THE GLASSHOUSE

In Baguio the disease appears in the glasshouse at any time of the year as long as there are tomato plants growing. It becomes more prevalent and serious during the rainy season or cooler and moister months of the year, i. e., July, August, and September, when severe losses may be experienced, but during the summer months, i. e., March, April or other drier months, the disease becomes less serious, so that a fairly good crop may be harvested. It is not known how long the fungus may persist in the glasshouse after infected vines have been pulled out, but in a series of plantings made in the glasshouse natural infection was still noted after the tomatoes have not been grown from 4 to 8 months, indicating that the fungus is still viable to cause infection from one tomato season to the next.

### SEASONAL OCCURRENCE OF THE DISEASE IN THE FIELD

The tomato leafmold is generally a glasshouse disease, but under Baguio climate it develops normally, and under certain conditions it may become as serious on tomatoes in the field as those noted in the glasshouse. In a series of tests slightly infected plants from the glasshouse of Burpee's Self Pruning, Break O'Day, Chalk's Early Jewel, Marglobe, Stone, Golden Queen, and Burpee's Matchless tomato varieties were set in rows into an isolated Plant Pathology plot on January 9, 1936. When notes were made after 1½ months from the date of planting, typical lesions with abundant sporulations were noted, and later on the disease spread to the upper leaves. The malady, however, became less prevalent during March and April when the weather was much warmer and drier, but it persisted on these plants until June.

No attempt was made to determine whether or not the disease could survive all the year round in the open field in Baguio, but from our experiments it may persist as long as there are growing tomato plants, since infected plants left outside with or without shade during the rainy months or during the

other drier months continued to have the disease until the plants were killed by another but more aggressive tomato disease caused by *Phytophthora infestans* (Mont.) de Bary.[4]

### INFLUENCE OF ENVIRONMENT ON DISEASE DEVELOPMENT

The fungus was shown by various authors(10), (12), (15) to be greatly influenced by temperature and humidity of the air in order to produce the disease. Small(12) found that the optimum temperature for various stages of leafmold is about 22° C, and that at 10° and 15° C severe infection occurs under humid condition, but the disease develops slowly. He further found that the humidities of the air exceeding 90 per cent are very favorable. At 22° C, which is the optimum temperature, infection in severe when the humidity is at 80 per cent, but rare at 70 per cent, while at 18° C infection and subsequent development are considerably retarded at 80 per cent humidity. No attempt was made to study the relation of temperature and humidity to disease development, but, from Table 3 which shows the monthly average minimum and maximum relative humidity and temperature of the air in Baguio for 5 years, it can be seen that the climatic conditions of this mountain region is favorable at any time of the year for the development of the disease, with more serious consequences occurring during the rainy months of the year when the humidities of the air outside and in the glasshouse becomes very high.

### LIFE HISTORY OF FUNGUS IN RELATION TO DISEASE PRODUCTION

Aside from the spores which may survive the unfavorable period in the glasshouses, the fungus is also known to tide over by forming from the dead infected tissues sclerotial-like or perithecial-like structures from which the conidiophores and conidia are produced when the conditions become more favorable. The conidia or spores which are produced usually first infect the lower leaves by penetrating through the stomata. The fungus soon after entering establishes its parasitic habit, spreads through the tissues and in a few days produces the typical lesions on the leaves. From these lesions abundant spores are produced and the disease is further spread to the other leaves, or to other plants in the glasshouse by wind, by splashing

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[4] The late blight disease, caused by *Phytophthora infestans* (Mont.) de Bary is generally serious under field conditions in Baguio, but it does not usually appear in our glasshouse which has much warmer temperature than outside field conditions.

of water during watering, or they may be transported to other sections of the glasshouse with the soil, with the infected vines, or by clinging with the working tools, clothings, and hands, so that in a few weeks time, the leaves of every plant may be all affected.

TABLE 3.—*The average monthly maximum and minimum temperatures and relative humidities of the air in Baguio for the years 1932–1936* [a]

| Month | Temperatures | | | Relative humidities | | |
|---|---|---|---|---|---|---|
| | Average maximum | Average minimum | Average | Average maximum | Average minimum | Average |
| January | 22.06 | 12.50 | 17.28 | 94.04 | 65.70 | 79.87 |
| February | 22.00 | 13.80 | 17.90 | 92.98 | 65.44 | 79.21 |
| March | 23.20 | 13.80 | 18.50 | 94.01 | 67.32 | 80.66 |
| April | 23.84 | 13.16 | 18.50 | 95.56 | 70.42 | 82.99 |
| May | 23.56 | 15.84 | 19.70 | 95.96 | 77.00 | 86.48 |
| June | 23.16 | 15.53 | 19.34 | 97.88 | 78.18 | 88.03 |
| July | 21.50 | 15.52 | 18.50 | 98.48 | 83.50 | 90.99 |
| August | 21.90 | 15.40 | 18.60 | 98.12 | 81.78 | 89.95 |
| September | 22.32 | 15.60 | 18.96 | 97.08 | 82.32 | 89.70 |
| October | 22.32 | 15.16 | 18.74 | 97.22 | 78.06 | 88.14 |
| November | 22.64 | 14.40 | 18.50 | 95.42 | 71.52 | 83.47 |
| December | 22.46 | 13.90 | 18.18 | 91.32 | 68.62 | 79.97 |
| Total | 270.96 | 174.61 | 222.70 | 1,148.07 | 889.86 | 1,019.46 |
| Average | 22.58 | 14.55 | 18.56 | 95.67 | 74.15 | 84.95 |

[a] The data herein reported were obtained through the courtesy of the Baguio Observatory, Weather Bureau.

While the initial infection of the season may start from spores which are able to tide over, these sclerotial-like structures formed from the diseased tissues which are also noted in Baguio, or the mycelium on the infected seeds are, however, potential in carrying the disease over from one tomato season to another or transporting the malady from one locality to another.

## SUSCEPTIBILITY OF TOMATO VARIETIES TO LEAFMOLD

As far as known, nearly all the commercial varieties of tomato, *Lycopersicum esculentum* L., are susceptible to the leafmold disease (1), (8), (11), but the degree of susceptibility varies with the different varieties. Jagger (8) and Small (11) tested several varieties and found Stirling Castle, Up-to-Date, Norduke, Main Crop, Satisfaction, and Frogmore as only partially resistant. Alexander (1) in his recent study also found that, of the 180 varieties tested, the above mentioned varieties were listed as partially resistant, while the Red Currant tomato, *L. pimpinellifolium* Dunal, was resistant. In our test, 20 varieties of

both American and native tomatoes were all found susceptible, with the Native, Oblong, Chalk's Early Jewel, Stone, Break O'Day, Marglobe, Burpee's Matchless, Burpee's Tangerine, Burpee's Self Pruning, and Burpee's Trucker's Favorite less affected than the other varieties. Table 4 shows the relative susceptibility of different tomato varieties to the leafmold disease.

## PROGRESS ON SELECTION OF TOMATO RESISTANT TO LEAFMOLD

Since all these varieties are susceptible, attempts were made at selection of resistant strains from those which were found to do well in the glasshouse. In this study, unless otherwise stated, the seeds of different commercial tomatoes were planted in short rows in the glasshouse bench, and when they were 7 to 8 inches high the two most vigorous seedlings were transplanted

TABLE 4.—*Relative susceptibility of tomato varieties to leafmold, C. fulvum Cke.*

| Name of varieties | Seedling plants[a] | | | Mature plants[b] | | |
|---|---|---|---|---|---|---|
| | Number of seedlings observed | Percent infected | Remarks on leaf-mold infection[c] | Number of plants observed | Percent infected | Remarks on leaf-mold infection |
| Native No. 1, small fruited | 40 | 100 | + | 2 | 100 | +— |
| Native No. 2, big fruited | 44 | 100 | ++ | 2 | 100 | + |
| Oblong | 38 | 100 | + | 2 | 100 | + |
| Yellow plum | 15 | 100 | + | 2 | 100 | ++ |
| Red Pear | ------ | ------ | ------ | 2 | 100 | ++ |
| Sunnybrook Earliana | 50 | 100 | +++ | 2 | 100 | ++ |
| Spark's Earliana | 28 | 100 | +++ | 2 | 100 | +++ |
| Penn State Earliana | 33 | 100 | ++ | 2 | 100 | ++ |
| Golden Dwarf Champion | 27 | 100 | ++ | 2 | 100 | ++ |
| Golden Queen | 43 | 100 | ++ | 2 | 100 | ++ |
| Chalk's Early Jewel | 14 | 100 | + | 2 | 100 | + |
| June Pink | 31 | 100 | +++ | 2 | 100 | ++ |
| Stone | 46 | 100 | + | 2 | 100 | + |
| Burpee's Fordhook First | 43 | 100 | + | 2 | 100 | ++ |
| Burpee's Matchless | 17 | 100 | + | 2 | 100 | + |
| Burpee's Tangerine | 39 | 100 | ++ | 2 | 100 | + |
| Burpee's Self Pruning | 33 | 100 | ++ | 2 | 100 | + |
| Burpee's Trucker's Favorite | 30 | 100 | ++ | 2 | 100 | + |
| Break O'Day | 23 | 100 | + | 2 | 100 | + |
| Marglobe | 36 | 100 | + | 2 | 100 | + |

[a] Seedlings were grown in short rows in the glasshouse.

[b] The mature plants were grown in the glasshouse bench and leafmold infection was observed from time to time.

[c] + —, trace to slight infection; lesions prominent, sporulation slight: + slight to serious infection; lestions prominent, sporulation quite abundant: + + serious infection; lesions prominent, sporulation dense and a number of leaves dry up: + + + Very serious infection; lesions very prominent, sporulation very dense, and many leaves turn yellow, dry up and fall off.

in permanent rows, spaced at 70 to 75 cm. between the rows and 50 cm. between the plants. In some cases, the seeds were first started in seed boxes, the seedlings were pricked at 8 to 10 cm. apart, and later the two best plants of each variety or "strain" were transplanted in permanent bench in the glasshouse as mentioned above. In these studies the plants were all exposed to natural infection, and notes on the disease were made throughout the season. As an index on resistance or susceptibility, the type of lesion, density of sporulation, the per cent of yellowing and drying up of the leaves, and the yield were taken into consideration. At the end of the season, the seeds of the high yielding, more "resistant strains" were saved and planted during the next tomato season, while the poor yielding and more susceptible ones were either eliminated or planted again as an index of resistance on the selected strains, and also served as a source of inoculum for the disease.

TABLE 5.—*Observation on the relative susceptibility of tomatoes to leafmold, C. Fulvum Cke.*

| Name of varieties | Number of plants observed | Number of fruits produced | Remarks on leaf-mold infection[a] |
|---|---|---|---|
| Native—R29-8-1 | 2 | 65 | +— |
| Burpee's Matchless | 1 | 3 | +— |
| Burpee's Tangerine | 1 | 30 | +— |
| Burpee's Self Pruning | 1 | 13 | +— |
| Burpee's Trucker's Favorite | 2 | 17 | +— |
| Burpee's Fordhook First | 1 | 8 | ++ |
| Marglobe | 2 | 7 | +— |
| Break O'Day | 2 | 20 | +— |
| Chalk's Early Jewel | 2 | 30 | +— |
| Golden Dwarf Champion | 2 | 23 | + |
| June Pink | 2 | 14 | —— |
| Sunnybrook Earliana | 1 | 13 | ++ |
| Spark's Earliana | 1 | 7 | ++ |
| Penn State Earliana | 1 | 6 | ++ |
| Yellow Plum | 2 | 44 | ++ |
| Red Pear | 2 | 75 | +— |

[a] — absent to trace; +— trace; + slight to serious; ++ serious; +++ very serious.

*Series 1.*—In this first series, samples of seeds from all the varieties were planted in short rows, and when the seedlings were 8 to 10 inches high the best two plants were planted in the glasshouse bench. In this trial, leafmold appeared late and infection was slight, so that a fair yield was gathered. As shown in Table 5, the Native, Burpee's Matchless, Burpee's Tangerine, Burpee's Self Pruning, Burpee's Trucker's Favorite, Mar-

globe, Break O'Day, Chalk's Early Jewel, June Pink and Red Pear were slightly affected. Because of apparent resistance and prolificacy, the Native, Burpee's Matchless, Burpee's Tangerine, Burpee's Self Pruning, Marglobe, Break O'Day, and Chalk's Early Jewel were selected as "promising strains," or varieties.

*Series 2.*—In this series, seeds from "promising strains" or varieties mentioned above were planted in short rows on October 22, 1934. As check, nine other unselected varieties were also planted. On December 2, the best two plants were transplanted in the bench and each plant was given a number, as No. 1 and No. 2 selections of the variety. Leafmold infection was noted early in the season, but because the weather was less favorable at this time, the disease did not become serious until the plants were in the flowering and fruiting stages. The result which are summarized in Table 6 show that the selections from the Native, Burpee's Matchless, Burpee's Self Pruning, Marglobe, Stone, Chalk's Early Jewel, June Pink, Spark's Earliana, Penn State Earliana, and Golden Queen produced a total average weight of fruits ranging from over a kilo to over two kilos depending upon the "strain," while poorer yield was obtained from the other varieties. In this connection, it will also be noted that generally all No. 1 plants yielded higher than the No. 2 plants of the same selection and planted in the same bench. This difference was perhaps due to the fact that the No. 1 plants were planted near the aisle where there was more free air circulation than those of No. 2 plants which were planted near and along the side of the glasshouse. In the more "resistant" strains, however, the location of planting did not greatly affect their yield as those noted of the more susceptible strains.

*Series 3.*—In this series, seeds of plants No. 1 from Burpee's Self Pruning, Marglobe, Break O'Day, and June Pink together with some of the high yielding strains from Series 2, were sown in short rows in the glasshouse on June 15, 1935. The best two plants were again transplanted on July 24. This planting coincided with the rainy season, and in about one month from date of planting the lower leaves of most of the varieties were already affected. The disease became very serious that in less than three weeks' time nearly all the leaves were affected and, sooner or later, many leaves turned yellow, dried up, and fell off, or remained attached to the plants. From Table 7, in spite of the severe infection, Burpee's Self Pruning yielded

better, while the other strains, either succumbed earlier or if they survived their yields they were greatly reduced.

TABLE 6.—*Observation on the relative susceptibility of tomatoes to leafmold, C. Fulvum Cke.*

| Name of varieties | Total fruits harvested | Total weight of fruits | Average weight of fruits | Average size of fruits | Remarks on leafmold infection [a] |
|---|---|---|---|---|---|
| Native: | | *Grams* | *Grams* | *Cm.* | |
| Plant 1 | 53 | 2,320.0 | 43.8 | 4.2 | + |
| Plant 2 [b] | 30 | 1,243.0 | 41.4 | 4.0 | + |
| Plant 5 | 30 | 1,786.0 | 59.5 | 5.0 | + |
| Burpee's Matchless: | | | | | |
| Plant 1 | 34 | 2,383.0 | 70.1 | 5.0 | + |
| Plant 2 | 9 | 657.0 | 73.0 | 5.0 | + |
| Burpee's Tangerine: | | | | | |
| Plant 1 | 9 | 566.0 | 62.9 | 4.4 | +— |
| Plant 2 [c] | --------- | --------- | --------- | --------- | --------- |
| Burpee's Self Pruning: | | | | | |
| Plant 1 | 18 | 1,661.0 | 92.3 | 5.3 | + |
| Plant 2 | 20 | 1,253.0 | 62.6 | 4.5 | + |
| Marglobe: | | | | | |
| Plant 1 | 14 | 1,554.0 | 111.0 | 5.5 | +— |
| Plant 2 | 13 | 971.0 | 74.7 | 4.17 | +— |
| Break O'Day: | | | | | |
| Plant 1 | 15 | 1,201.0 | 80.1 | 4.7 | + |
| Plant 2 | 10 | 469.0 | 46.0 | 3.7 | + |
| Chalk's Early Jewel: | | | | | |
| Plant 1 | 19 | 1,155.0 | 60.8 | 4.6 | +— |
| Plant 2 | 21 | 1,152.0 | 54.8 | 3.0 | +— |
| Burp. Truck Favorite: | | | | | |
| Plant 1 | 7 | 866.0 | 123.7 | 6.5 | +— |
| Plant 2 | 0 | --------- | --------- | --------- | +— |
| Burpee's Fordhook First: | | | | | |
| Plant 1 | 28 | 1,057.0 | 37.7 | 3.6 | ++ |
| Plant 2 | 11 | 391.0 | 35.5 | 3.3 | ++ |
| Stone: | | | | | |
| Plant 1 | 23 | 1,464.0 | 64.6 | 4.7 | +— |
| Plant 2 | 20 | 1,023.0 | 46.5 | 4.2 | +— |
| June Pink: | | | | | |
| Plant 1 | 23 | 1,525.0 | 66.3 | 4.8 | + |
| Plant 2 | 20 | 1,305.0 | 65.2 | 4.5 | + |
| Golden Queen: | | | | | |
| Plant 1 | 53 | 2,926.0 | 55.2 | 4.3 | ++ |
| Plant 2 | 13 | 810.0 | 62.3 | 4.6 | ++ |
| Golden Dwarf Champion: | | | | | |
| Plant 1 | 23 | 968.0 | 42.0 | 3.7 | ++ |
| Plant 2 | 20 | 966.0 | 48.3 | 3.8 | ++ |
| Sunnybrook Earliana: | | | | | |
| Plant 1 | 18 | 1,194.0 | 66.3 | 5.1 | ++ |
| Plant 2 | 9 | 656.0 | 76.2 | 4.8 | ++ |
| Spark's Earliana: | | | | | |
| Plant 1 | 21 | 1,275.0 | 60.7 | 4.5 | ++ |
| Plant 2 [c] | --------- | --------- | --------- | --------- | ++ |
| Penn State Earliana: | | | | | |
| Plant 1 | 35 | 2,309.0 | 66.0 | 4.5 | ++ |
| Plant 2 | 18 | 721.0 | 40.0 | 3.5 | ++ |

[a] +— trace; + slight to serious; ++ serious +++ very serious.
[b] Native No. 5 planted near the ailse on the other end of the glasshouse.
[c] Infected with mosic and the plant was pulled off.

TABLE 7.—*Observation on the relative susceptibility of tomatoes to leafmold, C. Fulvum Cke.*

| Name of varieties | Total fruits harvested | Total weight of fruits | Average weight of fruits | Remarks on leafmold infection [a] |
|---|---|---|---|---|
| | | *Grams* | *Grams* | |
| Burpee's Self Pruning: | | | | |
| Plant 1 | 10 | 840.0 | 84.0 | ++ |
| Plant 2 [b] | | | | |
| Marglobe Plant: | | | | |
| Plant 1 | 2 | 125.0 | 62.5 | ++ |
| Plant 2 | 2 | 115.0 | 57.5 | ++ |
| Break O'Day: | | | | |
| Plant 1 | 2 | 213.0 | 106.5 | ++ |
| Plant 2 [b] | | | | |
| June Pink: | | | | |
| Plant 1 | 6 | 160.0 | 26.6 | +++ |
| Plant 2 [b] | | | | |
| Sunnybrook Earliana: | | | | |
| Plant 1 | 4 | 213.0 | 53.2 | +++ |
| Plant 2 | 4 | 210.0 | 52.5 | +++ |
| Penn State Earliana: | | | | |
| Plant 1 | 0 | | | +++ |
| Plant 2 [b] | | | | |
| Golden Dwarf Champion: | | | | |
| Plant 1 | 1 | 40.0 | 40.0 | +++ |
| Plant 2 [b] | | | | |

[a] ++ serious; +++ very serious.
[b] Severely affected and pulled off before the fruits were set.

*Series 4.*—In this series, seeds of the high yielding No. 1 plants of Burpee's Self Pruning, Break O'Day, and Marglobe which showed very well in the last series were planted again on December 5, 1935. As check and for further observation on the other varieties, Chalk's Early Jewel, Burpee's Matchless, Golden Queen, Stone and Native were also planted. On January 4, 1936, six plants of each of the selected Burpee's Self Pruning, Break O'Day, and Marglobe strains were planted on one of the benches, and given selection numbers from 1 to 6, while two plants of each of the other unselected strains were planted in the other bench, and were also given numbers from 1 to 2. As shown in Table 8 the selections Nos. 1 to 5 of Burpee's Self Pruning (Plates 9 and 10) and plants Nos. 1 and 2 of Break O'Day (Plate 11) yielded satisfactorily with each plant giving a total weight of fruits ranging from 1,126 grams to 1,798 grams. The other varieties, even if leafmold was not very serious this season, yielded very poorly (Plate 12).

*Series 5.*—In this experiment, seeds of selections Nos. 1 to 6 of Burpee's Self Pruning, Selections No. 1 and No. 2 of Break O'Day and Selection No. 2 of Marglobe from the above series

were planted on May 1, 1936. The seedlings were pricked and on June 24, the best two plants of each selection were planted on the bench. As check, Golden Queen, Native, and an unselected Burpee's Self Pruning from the field were also planted. On August 4, leafmold infection was noted on the lower leaves of the Golden Queen, Native and Marglobe varieties. As the weather continued to be rainy during this time of the year, the environment in the glasshouse became so favorable that the disease spread very rapidly. Within three weeks time, from one-half to nearly all the leaves were infected, with the more susceptible Golden Queen, and the unselected Burpee's Self Pruning strain from the field more seriously attacked.

As shown in Table 9 the yield of the selections were greatly reduced, and in some cases no fruit was harvested. It will be observed also, that in some instances even the best selections obtained from the last series of the Burpee's Self Pruning failed to produce any fruit. This was not due all to leafmold, but partly due to nematode infection on the roots which resulted

TABLE 8.—*Observation on the relative susceptibility of tomatoes to leafmold. C. Fulvum Cke.*

| Name of varieties | Total fruits harvested | Total weight of fruits | Average weight of fruits | Average size of fruits | Remarks leafmold infection [a] |
|---|---|---|---|---|---|
| | | *Grams* | *Grams* | *cm.* | |
| *South bench* | | | | | |
| Burpee's Self Pruning: | | | | | |
| Selection 1 | 23 | 1,798.5 | 78.2 | 5.6 | +— |
| Selection 2 | 30 | 1,407.5 | 46.9 | 4.4 | +— |
| Selection 3 | 24 | 1,126.0 | 46.9 | 4.4 | +— |
| Selection 4 | 21 | 1,144.2 | 54.5 | 4.8 | +— |
| Selection 5 | 26 | 1,630.7 | 62.7 | 5.0 | — |
| Selection 6 | 24 | 979.4 | 40.8 | 4.1 | +— |
| Break O'Day: | | | | | |
| Selection 1 | 13 | 1,759.3 | 135.3 | 6.9 | +— |
| Selection 2 | 24 | 1,714.0 | 71.4 | 5.2 | +— |
| Selection 3 | 3 | 169.0 | 56.3 | 5.0 | +— |
| Selection 4 | 2 | 175.0 | 87.8 | 6.0 | +— |
| Marglobe: | | | | | |
| Selection 1 | 6 | 642.0 | 107.0 | 6.2 | +— |
| Selection 2 | 10 | 784.0 | 78.4 | 5.7 | +— |
| *North bench* | | | | | |
| Native: | | | | | |
| Plant 1 | 19 | 890.0 | 46.8 | 5.0 | +— |
| Plant 2 | 10 | 389.1 | 38.9 | 5.0 | +— |
| Stone: | | | | | |
| Plant 1 | 11 | 921.5 | 83.8 | 5.9 | +— |
| Plant 2 | 9 | 1,036.0 | 115.1 | 6.6 | +— |

[a] +— Trace to slight infection.

TABLE 8.—*Observation on the relative susceptibility of tomatoes to leafmold, C. Fulvum Cke*—Continued.

| Name of varieties | Total fruits harvested | Total weight of fruits | Average weight of fruits | Average size of fruits | Remarks on leaf-mold infection [a] |
|---|---|---|---|---|---|
| | | *Grams* | *Grams* | *Cm.* | |
| Golden Queen: | | | | | |
| Plant 1 | 11 | 615.0 | 55.9 | 4.9 | +— |
| Plant 2 | 8 | 377.5 | 47.2 | 4.9 | +— |
| Burpee's Matchless:[b] | | | | | |
| Plant 1 | 2 | ---------- | ---------- | ---------- | ++ |
| Plant 2 | 1 | ---------- | ---------- | ---------- | ++ |
| Chalk's Early Jewel:[c] | | | | | |
| Plant 1 | 0 | ---------- | ---------- | ---------- | +++ |
| Plant 2 | 0 | ---------- | ---------- | ---------- | +++ |

[a] +— Trace to slight infection; ++ serious; +++ Very serious.

[b] This variety is late maturing and only 3 green fruits were harvested on May 21, when the final notes were made.

[c] The plants were badly diseased with leafmold and powdery mildew and were pulled out early in the season.

in poor, stunted growth of the plants,[5] and the other reason was due to a certain insect which attacked the flowers and caused many of them to blight and drop off before the fruits are set.

From the results of these series mentioned above no variety or "strain" has been selected so far which is immune or highly resistant to the leafmold disease. The selections from Burpee's Self Pruning which in all these trials appeared to be more resistant and yielded higher than the other varieties, became also seriously affected (Plate 2) when extremely high humidity existed in the glasshouse, which environment is very ideal for epiphytotic development of the disease. But even at this extremely favorable conditions, Burpee's Self Pruning selections were able to yield better (Plates 9 and 10), while the unselected susceptible strain failed to produce any fruit, or succumbed before the end of the season. Furthermore, these selections when planted during the drier months of the year, when the disease is less serious, may yield even as much as twice more than the unselected susceptible strains (Plates 9, 10, 11, and 12).

In this connection, the type of growth of the plants, earliness of fruiting and prolificacy have some bearing in escaping or avoiding the leafmold disease. In these trials, Burpee's Self Pruning selections have the tendency to grow more erect, pro-

[5] The nematode disease, *Heterodera radicicola* (Greef) Muller, became very general in the glasshouse soil, but, in spite of it, some of the varieties were able to produce their fruits.

TABLE 9.—*Observation on the relative susceptibility of tomatoes to leafmold, C. Fulvum Cke.*

| Name of varieties[b] | Total fruits harvested | Total weight of fruits | Average weight of fruits | Remarks on leafmold infection[a] |
|---|---|---|---|---|
| | | *Grams* | *Grams* | |
| Burpee Self Pruning S-1: | | | | |
| Plant No. 1 | 0 | | | +— |
| Plant No. 2 | 0 | | | +— |
| Burpee Self Pruning S-2: | | | | |
| Plant No. 1 | 0 | | | +— |
| Plant No. 2 | 0 | | | +— |
| Burpee Self Pruning S-3: | | | | |
| Plant No. 1 | 0 | | | +— |
| Plant No. 2 | 0 | | | +— |
| Burpee Self Pruning S-4: | | | | |
| Plant No. 1 | 3 | 213.0 | 71.0 | +— |
| Plant No. 2 | 1 | 45.0 | 45.0 | +— |
| Burpee Self Pruning S-5: | | | | |
| Plant No. 1 | 10 | 666.0 | 66.0 | +— |
| Plant No. 2 | 12 | 872.0 | 72.7 | +— |
| Burpee Self Pruning S-6: | | | | |
| Plant No. 1 | 7 | 343.5 | 49.1 | +— |
| Plant No. 2 | 1 | 26.0 | 26.0 | +— |
| Burpee Self Pruning S-X: | | | | |
| Plant No. 1 | 0 | | | ++ |
| Plant No. 2 | 7 | 692.0 | 98.9 | ++ |
| Break O'Day S-1: | | | | |
| Plant No. 1 | 0 | | | + |
| Plant No. 2 | 0 | | | + |
| Break O'Day S-2: | | | | |
| Plant No. 1 | 0 | | | +— |
| Plant No. 2 | 1 | 55.5 | 55.5 | +— |
| Marglobe S-2: | | | | |
| Plant No. 1 | 2[c] | | | + |
| Plant No. 2 | 1 | 124.0 | 124.0 | + |
| Native: | | | | |
| Plant No. 1 | 4 | 148.5 | 37.1 | +— |
| Plant No. 2 | 2 | 73.0 | 36.5 | +— |
| Golden Queen S-2: | | | | |
| Plant No. 1 | 0 | | | ++ |
| Plant No. 2 | 0 | | | ++ |

[a] +— trace to slight; + Slight to serious; ++ serious.
[b] Nematode infection on the roots were noted from all the varieties.
[c] Two small green fruits were harvested. This is a late variety.

duce few branches and flowers, mature their fruit earlier, and are more prolific. Because of these qualities they had more chances to set, mature or ripen their fruits before the disease became general and serious in the glasshouse in Baguio. In the absence of a better variety, and if tomatoes have to be grown in the glasshouses in Baguio, Burpee's Self Pruning selections may be planted until better or even an immune strain could be developed.

## DISCUSSION AND SUGGESTION FOR CONTROL

The appearance of tomato leafmold, *C. Fulvum* Cke., in the Philippines, especially in Baguio, Mountain Province, where the climate is semi-temperate, is of scientific interest for this is the first record of it in the Philippines. Its becoming established or widespread in this region, however, is an added problem to vegetable growers considering that there are now so many plant diseases and plant pests problems which the farmers have to fight against. Fortunately, this malady is not yet widespread, nor has the culture of tomato under glasshouses become popular. Since this disease will likely become one of the limiting factors in the culture of tomato under glasshouses in Baguio, or in other regions with similar climate, the following control measures are suggested:

(1) Since the disease is greatly favored by temperatures between 20° to 22° C. and a relative humidity between 80 to 90 per cent or above, the glasshouses for tomato culture should be provided with adequate heating or ventilating system so as to maintain an environment below the requirements for the fungus to develop.

(2) Chemical fungicides for the control of this disease in the glasshouses have been recommended by various workers(2) (3) (6) (8) (14). According to Small(14), Ammonium copper carbonate, Colloidal Sulfur A and the Sodium Salt of Salicylanilide were found to be effective sprays, if Agral I [6] is added as spreader. Bewley and Orchard(2) reported excellent control with Salicylanilide paste or "Shirlan," combined with Agral I. Many writers, however, are not unanimous in recommending the use of sprays as a means of control, since the fungicides when applied could not cover the leaves thoroughly, and even at best, are not commercially successful.

(3) The control of the disease by fumigating an empty infected glasshouses before planting has been found very satisfactory and necessary in order to eliminate the disease. Small(14) obtained complete killing of spores in a glasshouse of 25,000 cubic feet capacity when fumigated with formalin (40 per cent) poured upon crystals of potassium permanganate at the rate of 1.25 pints of formalin plus .8 pound of potassium permanganate placed in 4 receptacles, or by the use of sulphur dioxide by burning flower of sulphur at the rate of 5 heaps of sulphur each of 5 pounds burned simultaneously. Magee(9)

[6] A sulphonated oil with a trade name known as Agral I.

also recommends fumigation with sulphur dioxide by using 10 pounds per 10,000 cubic feet burned in 5 or 6 heaps spaced at intervals in the receptacle in the floor of the glasshouse.

(4) The use of resistant varieties of tomato is the surest and cheapest means of control, if such varieties are in existence. At present, however, only partially resistant varieties are known, and these should be planted if found adaptable to local conditions. While no highly resistant or immune variety has been selected at present, our selections from Burpee's Self Pruning are recommended for glasshouse culture in place of other varieties which have been tested so far at this Station.

(5) Under Baguio conditions if tomatoes had to be grown in the glasshouse, and in the absence of resistant varieties, the planting should be made so that the crop does not coincide with the rainy or moister months of the year, thus avoiding the disease when it is most serious.

(6) In addition to these recommendations, strict sanitation and proper culture of plants in the glasshouses should be practised. Proper pruning of plants to induce thin growth, removal and burning of infected leaves or vines, and avoidance of excessive watering are very essential means of minimizing the occurrence and spread of the disease. Removal from the greenhouse and burning of infected vines after harvest should be followed from year to year so as to minimize the source of inoculum for initial infection from one crop of tomato to another.

## SUMMARY

1. The tomato leafmold, *C. fulvum* Cke., which is a troublesome glasshouse disease of tomato in the United States and in other temperate countries was noted for the first time in 1934 in Baguio, Mountain Province, Philippine Islands.

2. This disease is not yet widespread, as it is only observed in the glasshouse of the Baguio Plant Industry Experiment Station.

3. The disease appears in the glasshouse at any time of the year, but becomes more destructive during the rainy or moister and cooler months when it spreads very rapidly and causes many leaves to turn yellow, curl up and finally drop off.

4. The writer is not aware how this disease got into the Philippines, but, it is believed that it might have been introduced, since it is known to be transmitted with the seeds.

5. The disease is due to a fungus parasite, *C. fulvum* Cke. The spores of the species reported are slightly bigger, but are within the range of sizes given by Stevens.

6. The spores germinate readily in the presence of moisture in the glasshouse, in the laboratory, or in the open with or without shade in Baguio.

7. Experiments showed that tomatoes are readily infected and develop their symptoms within 10 to 15 days after inoculation with spores.

8. The spores are easily disseminated, and if the conditions are favorable the disease is spread by means of spores to all the plants within a few weeks in the glasshouse.

9. The longevity of the fungus in the glasshouse was not determined. Natural infection, however, was noted after tomatoes have not been planted from 4 to 8 months, indicating that the fungus remained viable for that length of time in the glasshouse in Baguio.

10. The disease is generally a glasshouse disease of tomato, but it may also occur normally in the field and under certain conditions it may become very serious.

11. The fungus is known to survive inclement weather by means of spores or by forming sclerotia-like structures from the infected tissues. From these means it may be perpetuated from one planting season to another, or it may be transported from one locality to another.

12. The fungus is favored greatly by temperatures between 20° and 24° C., and relative humidities between 80 to 90 per cent or above. The climate of Baguio is ideal and it is believed that this disease might become one of the serious diseases of tomatoes in the glasshouse or in the field of this region.

13. Results of experiments show that all tomato varieties are susceptible to the disease. None of the varieties tested was found to be resistant or immune. Our selections from Burpee's Self Pruning were found better than the other varieties, and these may be grown in the glasshouse until better ones are found.

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# ILLUSTRATIONS

### Plate 1

Glasshouse of the Baguio Plant Industry Experimental Station, where the leafmold disease was noted in 1934.

### Plate 2

Tomato plants (Burpee Self Pruning Selections) affected with leafmold disease *C. fulvum* Cke. showing the typical yellowing, drying and falling of the affected lower leaves. These plants were transplanted on June 24, 1936 and on August 4, leafmold was noted in the greenhouse. When notes were made on Sept. 19 nearly all the leaves were infected, and the lower leaves began to dry up and fall off. Photographed on September 19, 1936 when the plants were about three months old. Left to right, Burpee's Self Pruning Selection X, plant 1; Burpee's Self Pruning Selection No. 6, Plant 1; and Burpee's Self Pruning Selection No. 5, Plant 1.

### Plate 3

Healthy and infected leaves from stone tomato variety. The healthy leaf was obtained from the upper part of the plant while the infected leaf which is almost dried, was obtained from the lower part.

### Plate 4

Tomato leaves showing the symptoms of the leafmold disease.

Fig. 1. Lower surface of the leaf showing the small downy white patch of fungus growth.

2. Upper surface of the leaf showing the yellowish green tissues;
3. Lower surface of the leaves showing the light brown to dark velvety brown color due to heavy sporulation of the fungus. The tip of the leaflet is already dried due to the effect of the disease.

### Plate 5

Tomato leaves showing the advanced stages of the leafmold disease. The light brown and velvety dark brown areas on the lower surface of the leaves and drying of the leaves may be noted.

### Plate 6

Lower leaves affected with the leafmold disease.

Fig. 1. Upper surface of the leaf, showing the light green to yellowish green areas from which spores may also be produced. At X is a dark brown dead tissue involving nearly one-fifth of the leaf area.

FIG. 2. Upper surface of the leaflet showing numerous new lesions, with the characteristic whitish downy patch of fungus growth and the old sporulating areas which have dark velvety brown color.

PLATE 7

The tomato leafmold organism, *Cladosporium fulvum* Cke.

FIG. 1. Spores.

FIGS. 2, 3, 5, and 6 are germinating spores after 4, 8, 12, 24 hours, respectively.

FIG. 4. Conidiophores with some young undetached spores.

PLATE 8

Potted tomato plant artificially infected in the glasshouse by spraying spores of *C. fulvum* Cke. Photographed 25 days after inoculation.

PLATE 9

Burpee's Self Pruning Selections No. 1 to No. 6, growing in the glasshouse. Selection Nos. 1, 3, and 5, (left to right) are seen on the foreground while Selections Nos. 2, 4, and 6 not seen, are in the background just behind. In spite leafmold disease, these selections yielded very satisfactorily, while the unselected, susceptible strains yielded very poorly, and in certain instances failed to produce any fruit. Because of early *flowering* and *fruiting*, these plants have already matured and ripened fruits before the disease became serious. Planted, January 4, 1936 and photographed, April 15, 1936.

PLATE 10

Burpee's Self Pruning Selection No. 1. This plant produced 23 marketable size fruits weighing 1,798.5 grams. Planted January 4, 1936 and photographed April 15, 1936.

PLATE 11

Break O'Day Selections Nos. 1 and 2. These plants fruited also satisfactorily and yielded from 1,795.0 to 1,714.0 grams of fruits, respectively. Planted, January 4, 1936 and photographed, April 19, 1936.

PLATE 12

Golden Queen and Burpee's Matchless tomato varieties. These varieties are more susceptible and were more severely affected early in the season. These plants yielded very poorly as compared with either the Burpee's Self Pruning or with Break O'Day selections.

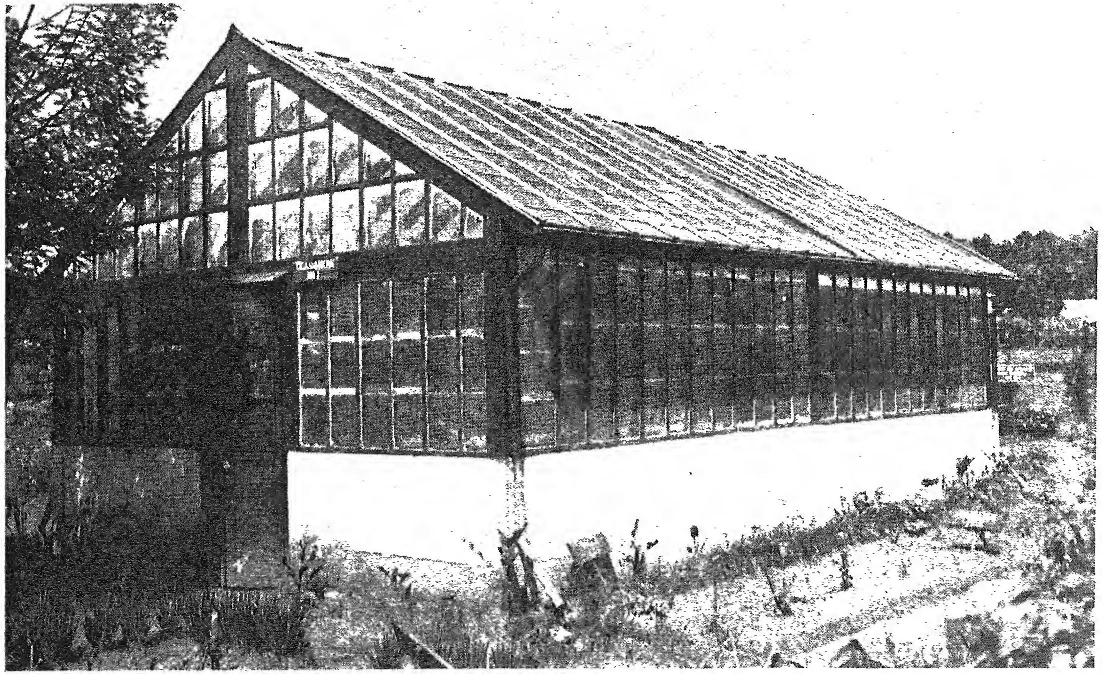
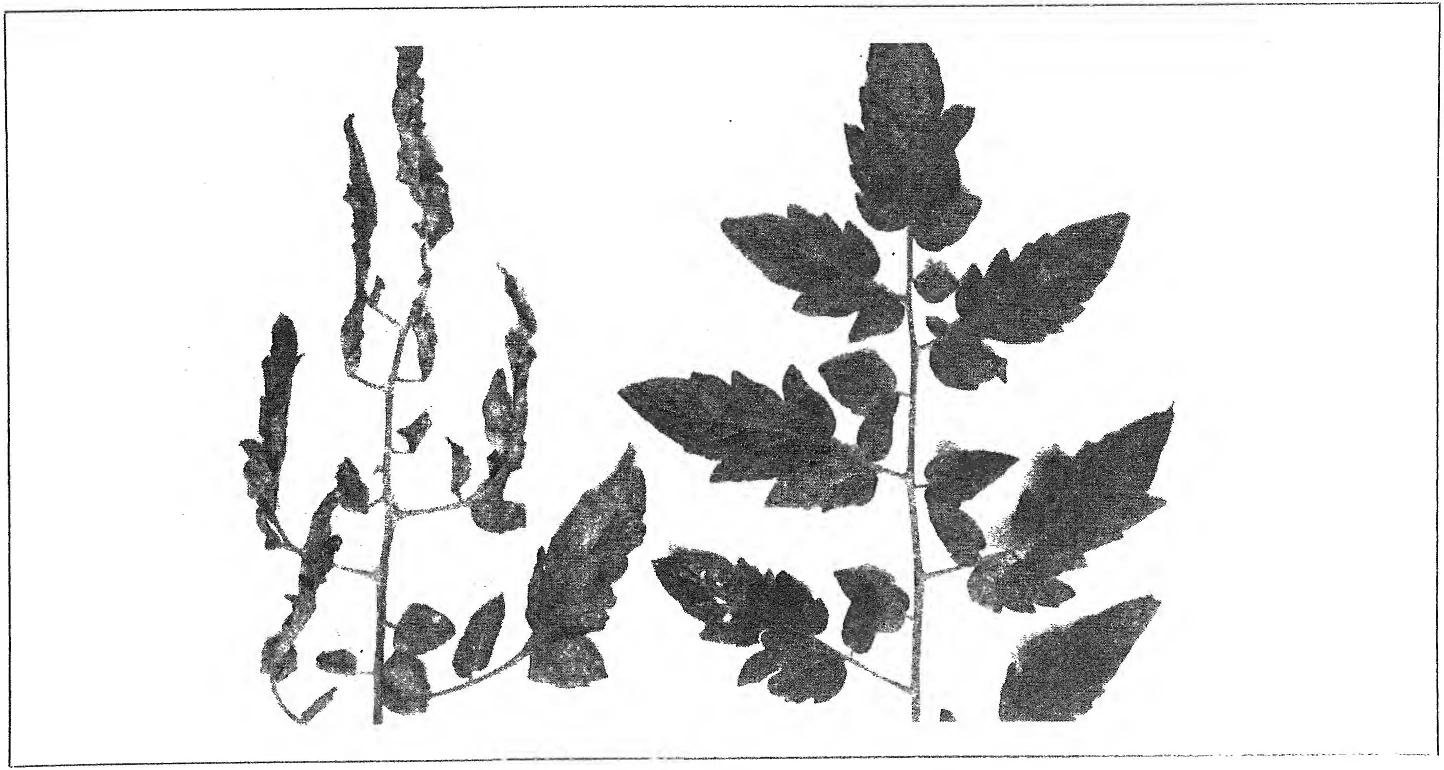


PLATE 1.

PLATE 2.



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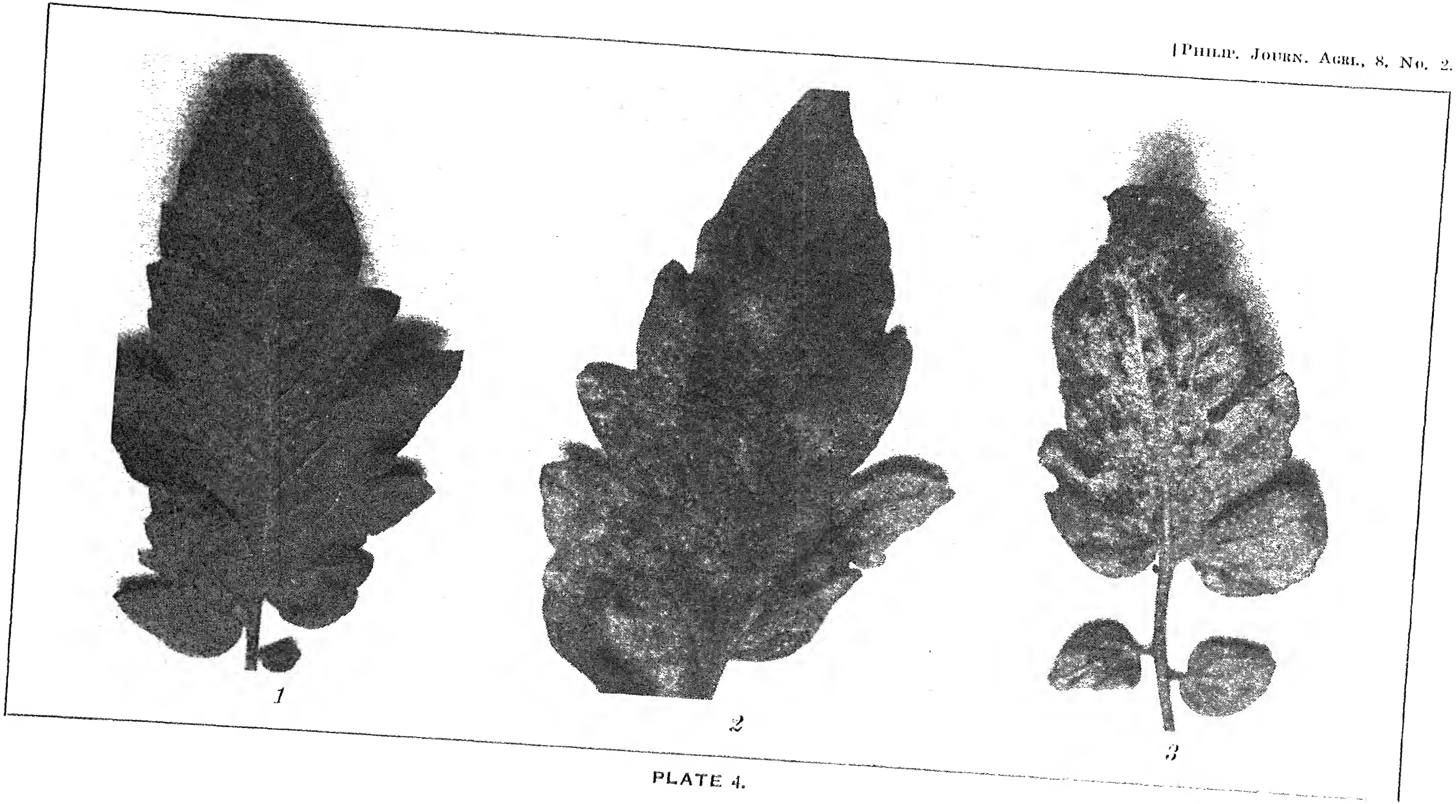


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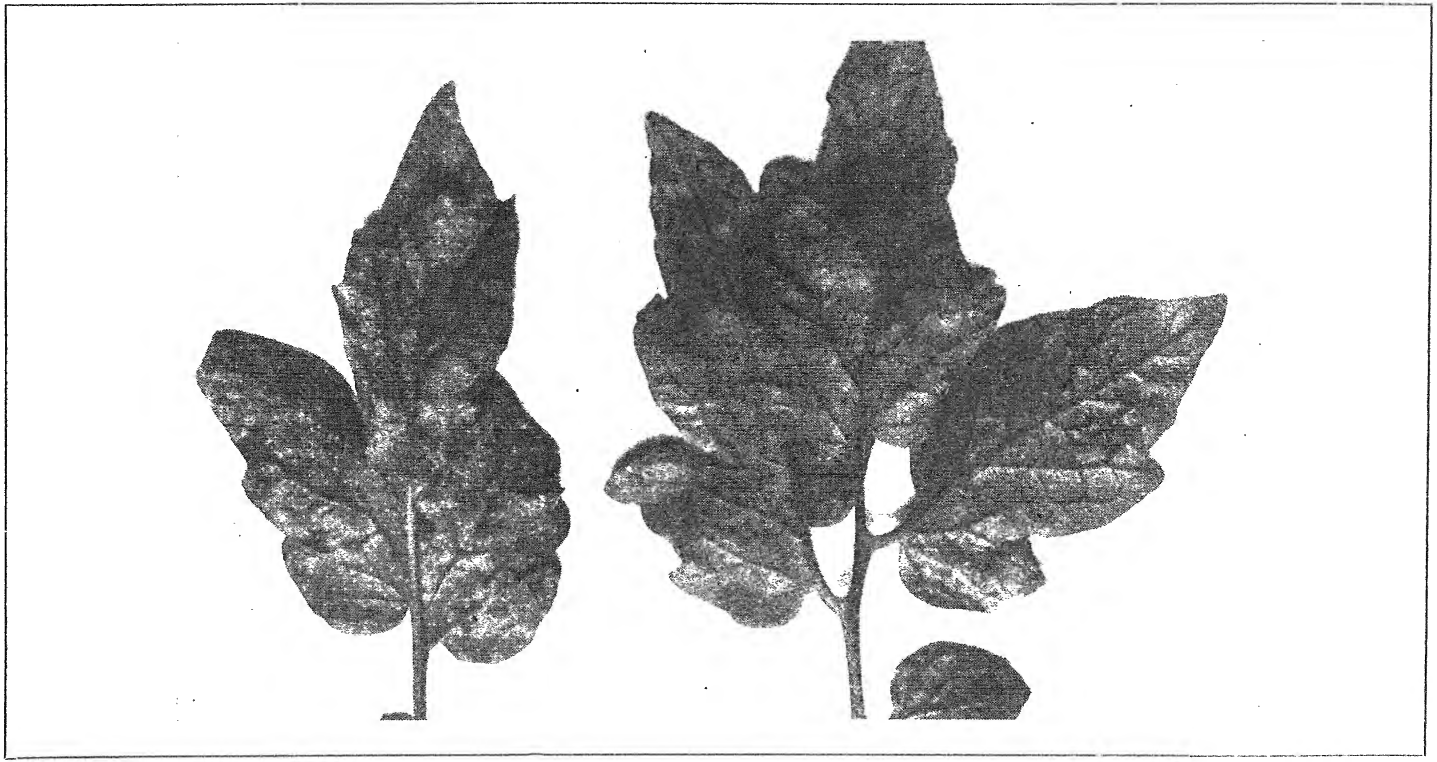

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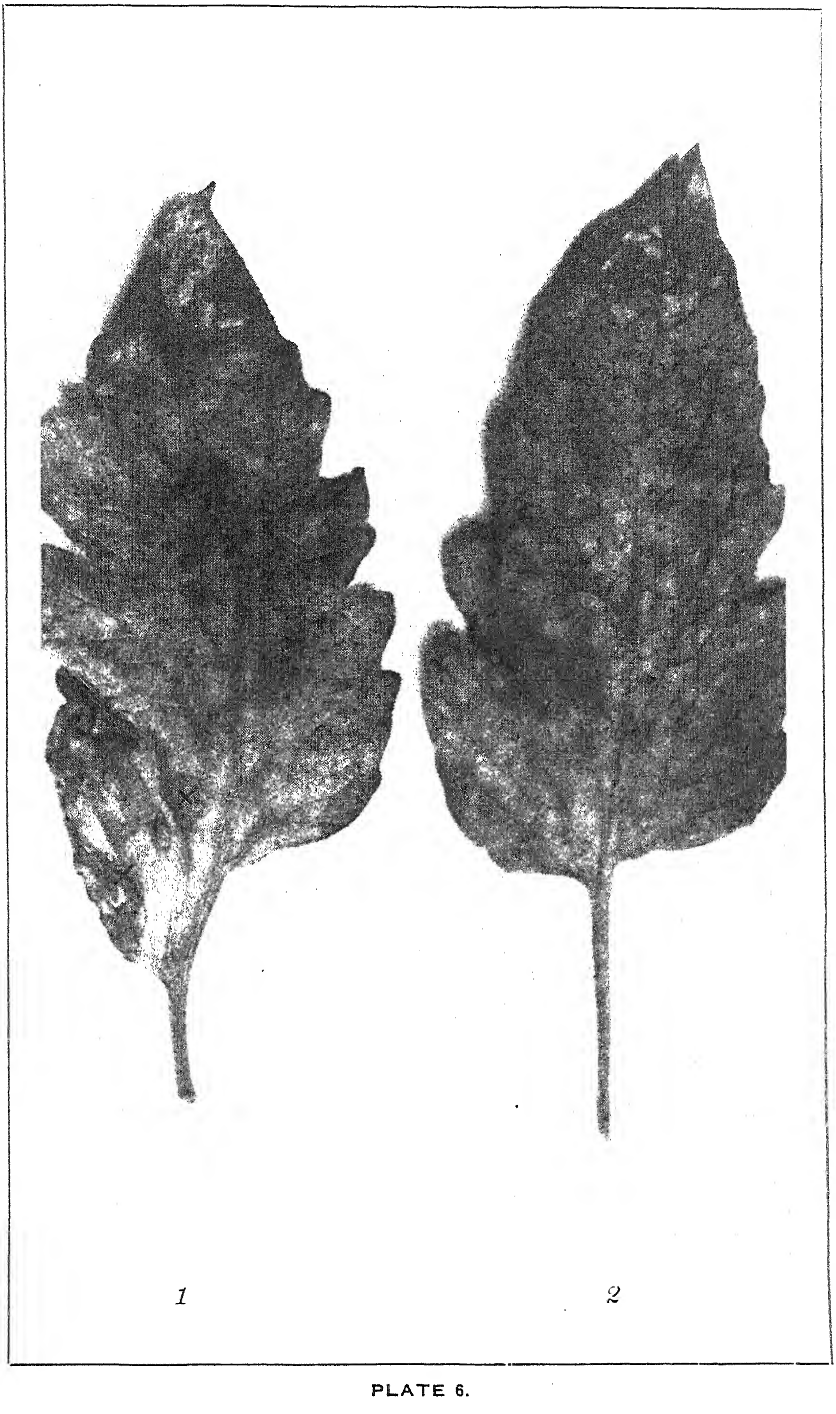

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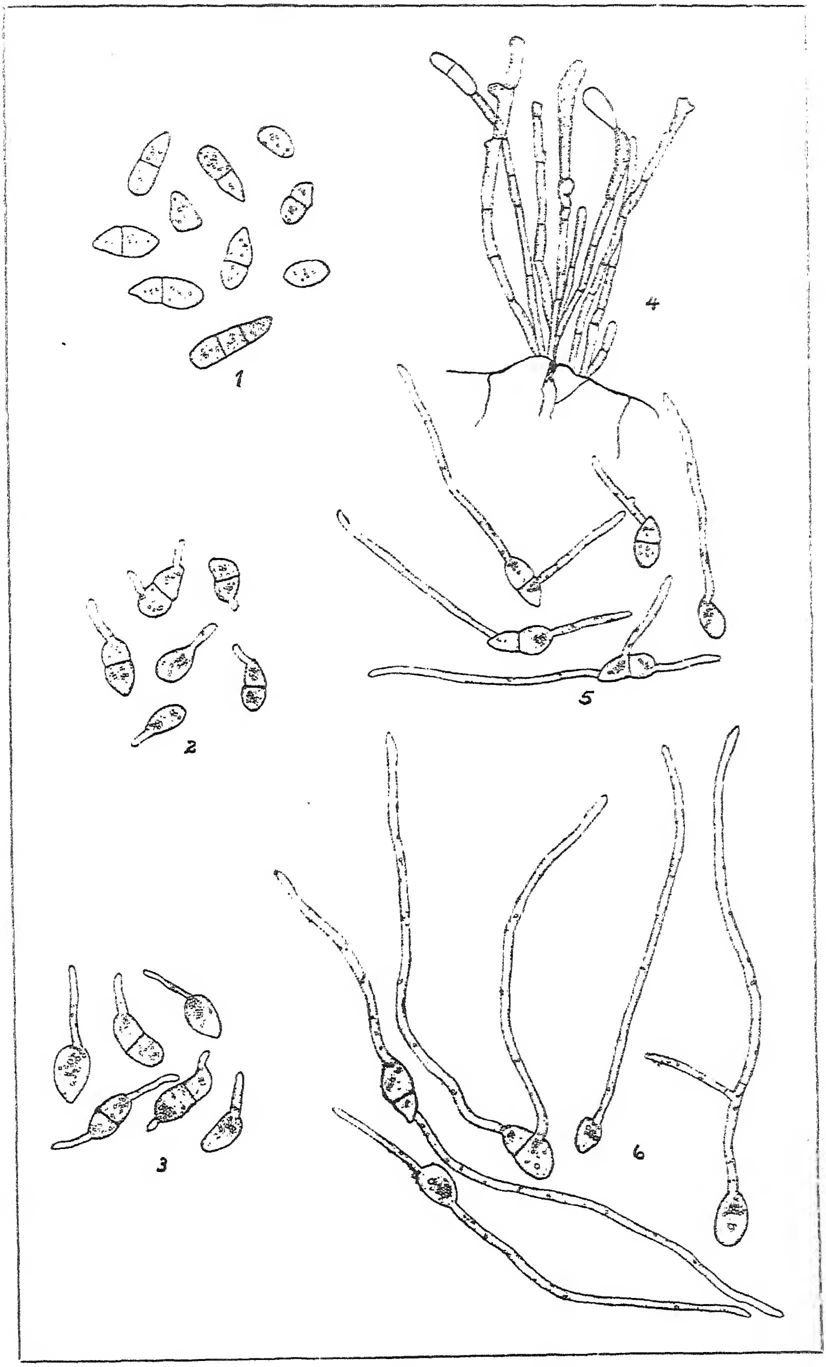


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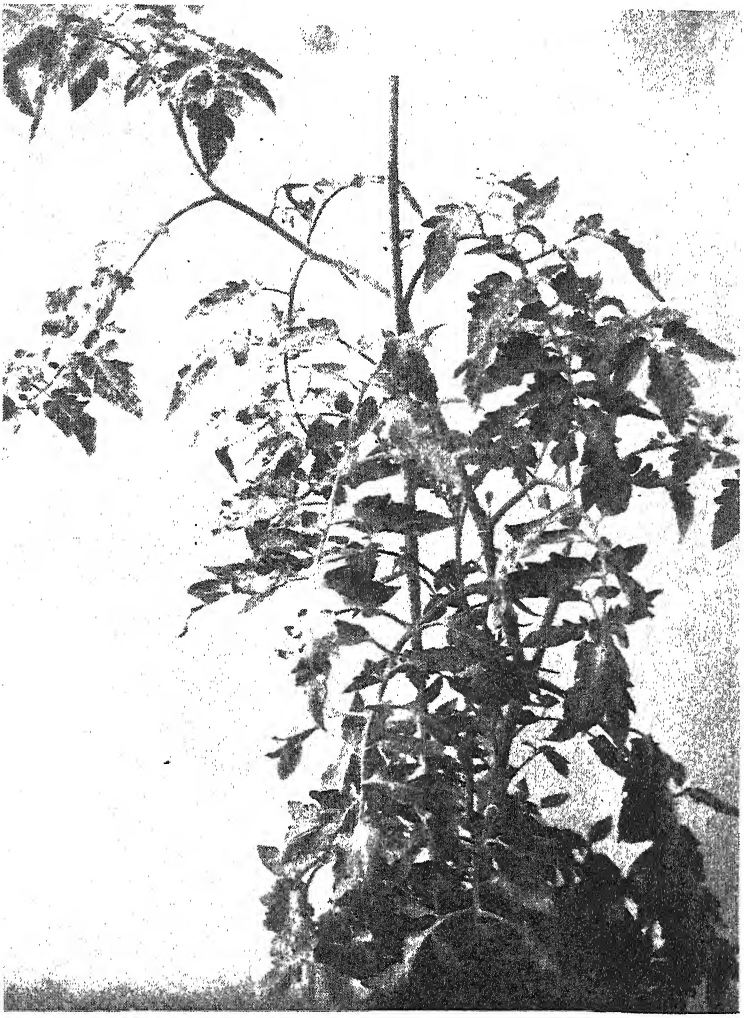
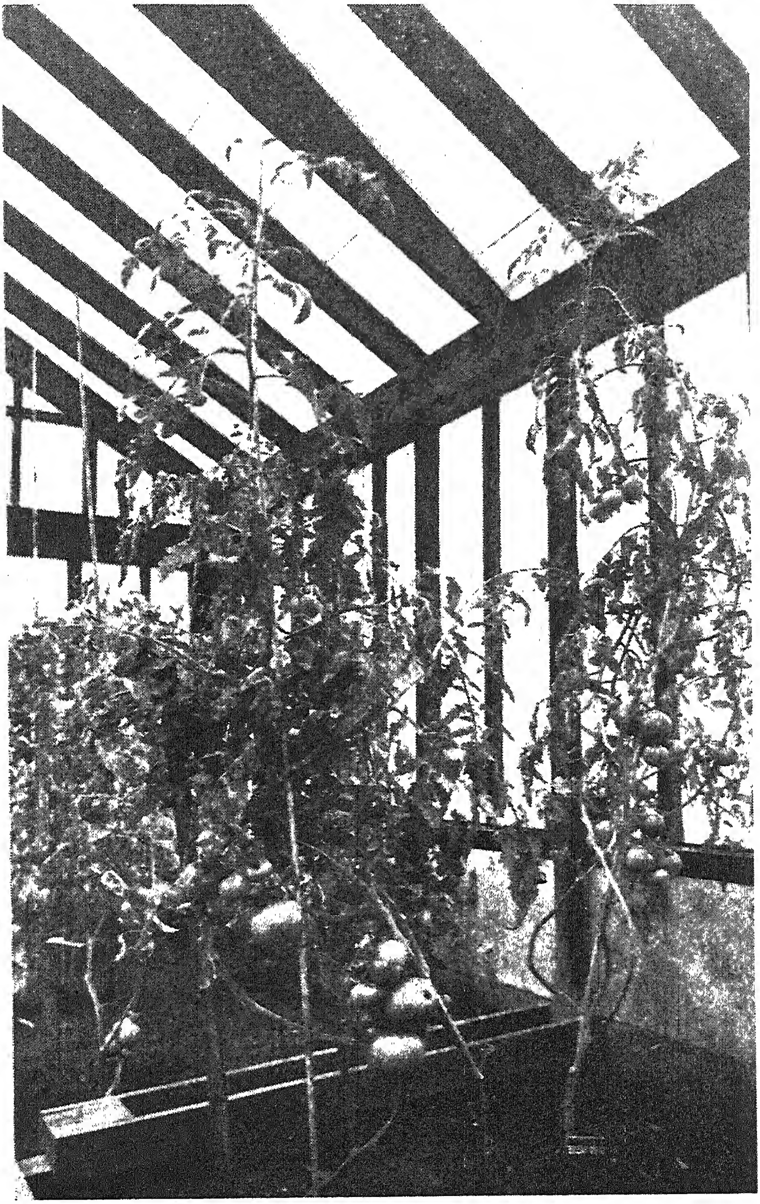


PLATE 2.

PLATE 9.

PLATE 10.



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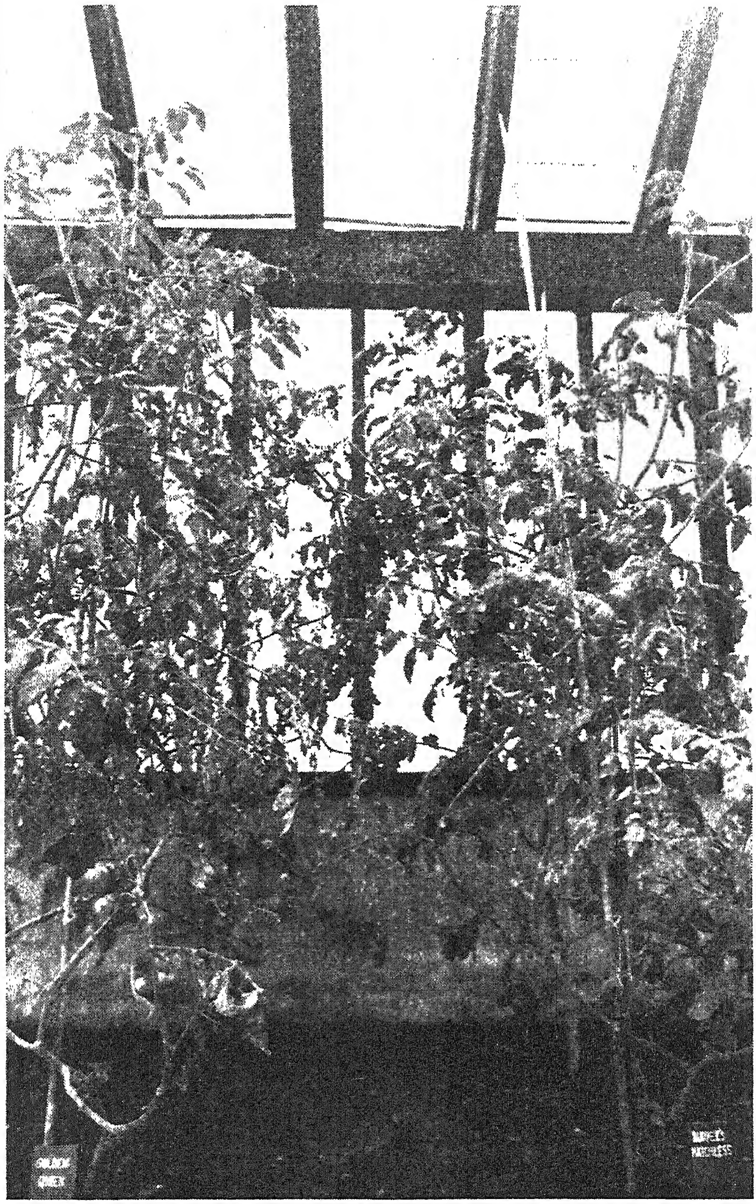

PLATE 12.

# THE SETTING OF CARABAO MANGO FRUITS AS AFFECTED BY CERTAIN SPRAYS

By F. G. GALANG and FELIX D. LAZO
*Of the Horticulture Section*

TWO TEXT FIGURES

Mango flowers which have been overtaken by rain, shower, heavy dew or otherwise even only mere high atmospheric humidity during the fertilization period appeared to have met with varying degrees of failure to develop into fruits. There were instances where a total or 100 per cent losses occurred due to these unfavorable factors. Yet, it involves a considerable expense to make a mango tree flower because it has a despairing characteristic of erratic flowering. While it is true that the mango could be forced to become active as to make it flower or send out flushes by smudging, up to the present time, however, no means has as yet been found which would make the flowers develop into fruits with certainty. Mango fruits produced out of season fetch a better price in the market; therefore, it gives a handsome financial return to the mango growers. Considering this together with the cost of inducing the tree to flower, the importance of the question of how to influence the setting of the mango flowers into fruits, or to save them from ruin frequently resulting from showery weather, becomes obvious and interesting.

Some efforts were directed toward this end. Thus Clara(1) in 1927 claimed that "invariably the trouble is the falling off flowers, during showery weather" and that it is caused by a fungus organism known as *Glomerella cingulata* (Stonem.) Schrenk and Spaul. It is evident from this report that spores of the disease were already present in the trees and that the showery weather effected the optimum condition for the development of the disease. On the other hand, Palo and Garcia(3) in their studies on the control of leaf-hoppers and tip-borers on mango inflorescence, state that "anthracnose disease was suspected as one of the factors responsible for the blighting of the flowers because of favorable weather (for the disease) but

isolation studies for its causative agent did not reveal its presence." If this were the case, perhaps preventive precaution before the humid conditions of the air would help the mango growers. Torres (5) sprayed once with tap-water some mango flowers which have been fertilized three days or more. In other words he sprayed very newly set fruits and some continued to develop so he reported in 1931 "that the mean percentage of setting for the unsprayed group was $1.60 \pm 0.26$ per cent as compared with $2.80 \pm 0.55$ per cent for the sprayed lot, thus, showing an insignificant difference of $1.20 \pm 0.60$ per cent in favor of the spray treatment," and the same author concluded, "that a single spraying with water does not prove harmful to the young ovaries." In India, it was reported by Hartless (2) that rain, cloudy weather, excessive humidity, storm, drought, frost, cold, and insects during the flowering period of the mango constitute the most important and frequent causes of failure of the crop. On the other hand, Popenoe (4) wrote that "the scanty productiveness of many Indian mangoes had been attributed . . . to defective pollination." To the same author is also accredited the claim that the mango pollen "grains show a decided tendency to cling together especially in damp weather."

Wellington et al. (6) seemed to agree with all the others in their opinions when he and his coworkers enumerated "the main factors affecting fruit setting" as "meteorological, nutritional, sexual, and agencies affecting pollination." To find out, at least in part, the idiosyncrasy of the mango flower with respect to humid weather and certain sprays, this study was undertaken.

The direct objective of this study was to find out the effects of rain, tap-water, Black-leaf "40" plus soap, Fungi-bordo, lime-sulphur and calcium arsenate on the setting of the Carabao mango flowers into fruits. In this study, however, it was necessary to have some kind of an insight in the characteristics and behavior of the flowers in order to have a better light in understanding whatever the manifestation of the sprays.

The study was carried at the mango orchard of the Lamao Horticultural Station, Limay, Bataan, during the smudging season of 1933 to 1936. The 1933–34 season was mostly devoted to the study of the silent characteristics and behaviors of the mango flowers. Actual spraying was conducted during the last two seasons mentioned. No test was made during the regular flowering periods for lack of suitable materials. The trees did not flower perhaps as Hartless (2) claims due to ex-

haustion. The trees have already flowered when they were smudged.

## MATERIALS AND METHODS

*Studies on the Carabao mango flowers.*—The plants which produced the flowers were grafted with selected scions. They were planted in 1923 in an orchard which has reddish clay loam soil. The plantation has a rather sloping topography, thus affording an excellent drainage.

When the buds became active as a result of smudging in December 1933 at least 50 buds were selected, labeled and numbered under each of the conditions, to wit, buds arising from terminal flushes and directly exposed or open to sunshine (terminal open), buds arising from terminal flushes but were shaded from the rays of the sun (terminal shaded), buds arising from lateral flushes and directly exposed to sunshine (lateral open), and buds arising from lateral flushes but were shaded (lateral shaded). When the buds were two to three days after they have shown external signs of activity, their daily elongation was taken individually until they ceased to elongate. The selected buds did not all develop into flower panicles as some of them were shoot buds. Others were attacked by tip-borers. Table 1 together with Chart 1 shows the average growth in length of 25 panicles each, of the four conditions mentioned above.

At what time of the day do most of the florets, or how many florets in a panicle open at a certain hour of the day was also a question of some importance. For this purpose, 15 panicles of normal growth and which had their first floret about to open were marked and closely observed. As soon as the florets in the panicles began to open, hourly observations from 6 a. m. to 6 p. m. were made. The number of perfect and imperfect (male) florets opening at every hour between 6 a. m. and 6 p. m. was determined separately in each of the 15 panicles marked. This observation continued until all the florets in the panicles under consideration have opened. To avoid possible confusion in the counting, the opened florets were pinched off with the aid of a pair of fine pointed forceps. Thus every floret found open during the succeeding observation must have done so during that particular hour. Only 10 of the 15 marked panicles successfully terminated the study. Some of them were accidentally broken in the course of the observation while two were destroyed by tip-borers. The results are presented in Table 2 and Chart 2.

The number of florets opening every day from the first until the last one in the panicle has opened, was likewise determined. It was desired to know how soon after the first floret has opened would most of them be ready to pollinate. The perfect and imperfect florets were separately recorded as shown in Table 3.

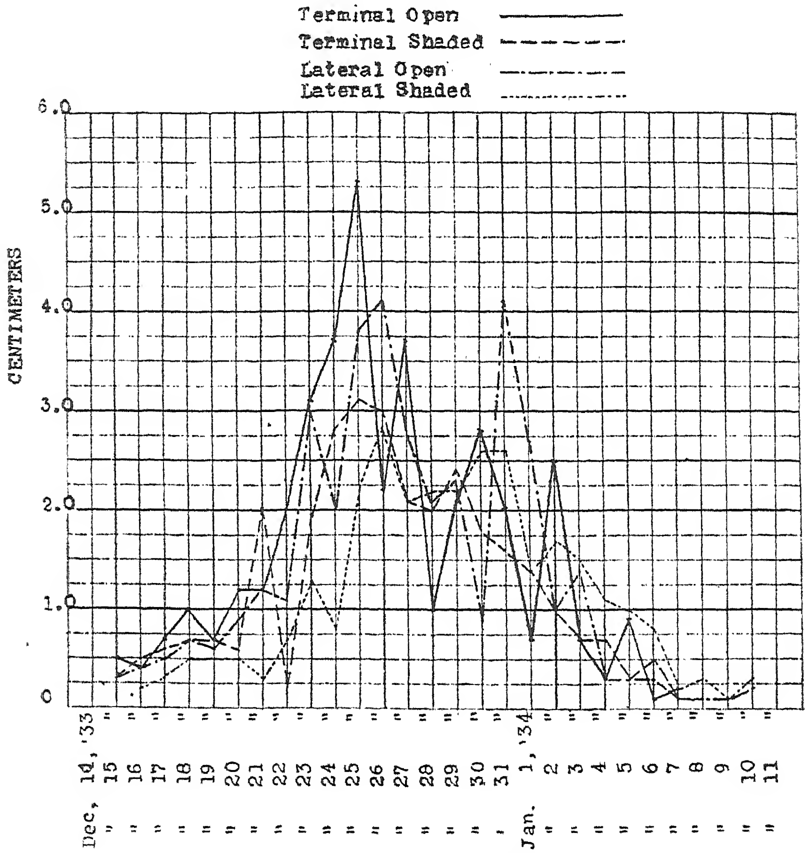


CHART 1. Average daily elongation of Carabao mango flower panicles.

The time it takes the anthers to open was studied with the aid of a watch and a hand lens. The moment the longitudinal suture of the anthers began to open and the time the opening was completed were recorded. Table 4 shows the results of the observation.

In the same manner as in determining the number of florets opening during certain hours of the day, the number of perfect and imperfect ones in the whole flower panicles were also studied. The point in view was to find out what per cent of the whole

panicle are staminate and what per cent are potential fruit forming florets. This will enable us to express approximately

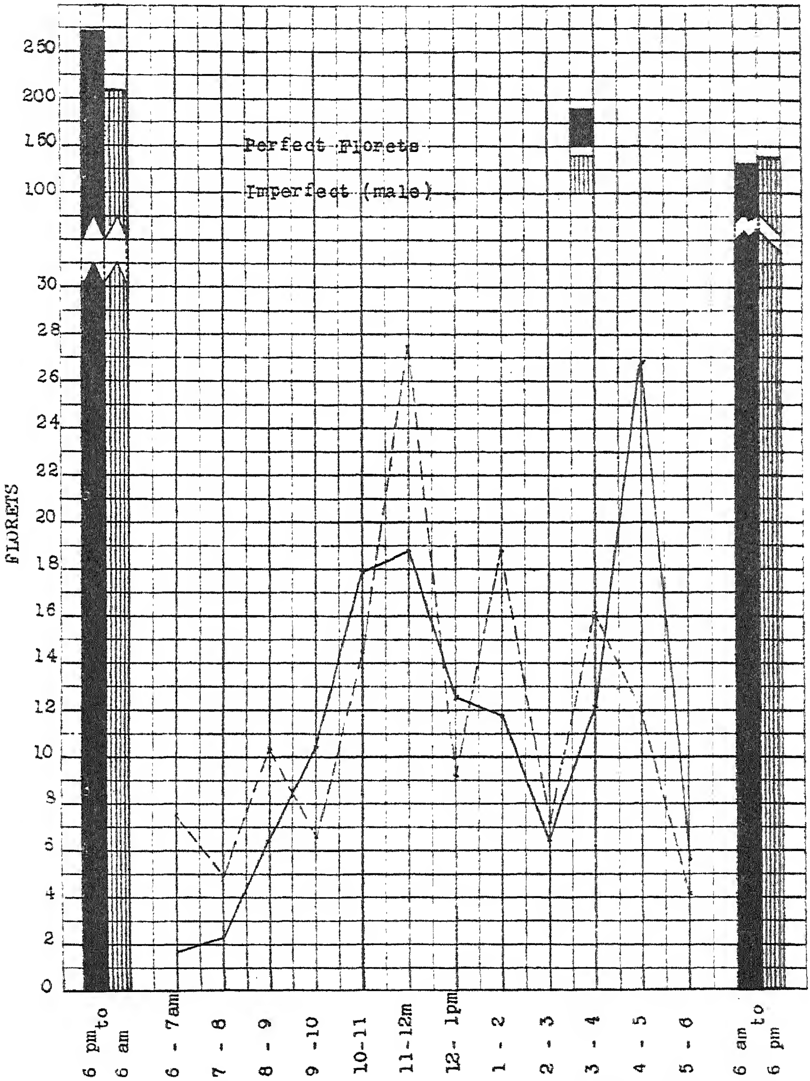


CHART. 2. Average number of florets opening in a Carabao mango flower panicle opening at different hours of the day

the fruit set in terms of per cent. Table 5 shows the summarized data on the number of florets per panicle of Carabao mango flower.

A closer external study of the florets and its behavior was undertaken. Figure 1 shows the oustanding external morphology of a typical Carabao mango perfect floret. The male floret is illustrated in Figure 2.

FIG. 1. A typical perfect floret of Carabao mango

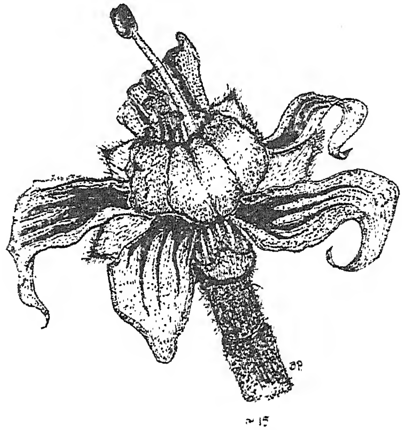

FIG. 2. A typical male floret of Carabao mango

*Spraying experiments.*—Armed with the findings about the mango flower, an endeavor to find the effects of chemical sprays, rain and tap-water was attempted. During the smudging season of 1934–35 some of the grafted Carabao mango trees flowered very profusely. Three trees which had nearly the same quantity of flower panicles throughout the crown were selected. The trees had well developed and more or less spherical crowns with about 12 meters diameter. When the rachises were about 10 cm. long, each of the crowns was divided into seven divisions by means of tying a bamboo pole vertically against the main trunk, allowing the upper end of the pole to protrude about two and a half meters above the crowns. At the end of the pole were tied seven pieces of abacá twine ($\frac{1}{8}$ inch in diameter) with convenient length. The other ends of the abacá twines were in turn tied to pointed sticks which were driven to the ground so that they were fixed.

The number of panicles in each division was carefully taken and recorded. The kind of treatment or spray was labeled to the division that received it. In the morning of January 26, 1935, at about 8.30 a. m., actual spraying was performed. A section or a division was not sprayed with anything in order to serve as control.

Another division was sprayed with rain water which was collected and stored in demi-johns during the preceding rainy

season. The spraying was accomplished with the aid of a hand pump, the nozzle of which was so adjusted that the spray came out in a fine mist. The flowers including all the other parts of the tree in the section were thoroughly sprayed. The nozzle was directed to the higher parts of the tree with the use of a light pole.

Another section was sprayed with ordinary tap-water obtained from the faucet at the nursery of the Lamao Horticultural Station. The water was applied in the same manner as the rain water.

TABLE 1.—*Showing the average daily elongation in centimeters of twenty-five each of Carabao mango flower panicles*

| Date | Terminal | | | | Lateral | | | |
|---|---|---|---|---|---|---|---|---|
| | Open | | Shaded | | Open | | Shaded | |
| | M | G | M | G | M | G | M | G |
| **1933** | | | | | | | | |
| December 14 | 0.9 | ------ | 0.7 | ------ | 0.5 | ------ | 0.5 | ------ |
| December 15 | 1.4 | 0.5 | 1.0 | 0.3 | 0.8 | 0.3 | 0.5 | ------ |
| December 16 | 1.8 | 0.4 | 1.5 | 0.5 | 1.2 | 0.4 | 0.7 | 0.2 |
| December 17 | 2.5 | 0.7 | 2.1 | 0.6 | 1.7 | 0.5 | 1.0 | 0.3 |
| December 18 | 3.5 | 1.0 | 2.8 | 0.7 | 2.4 | 0.7 | 1.5 | 0.5 |
| December 19 | 4.2 | 0.7 | 3.5 | 0.7 | 3.0 | 0.6 | 2.0 | 0.5 |
| December 20 | 5.4 | 1.2 | 4.1 | 0.6 | 3.9 | 0.9 | 2.5 | 0.5 |
| December 21 | 6.6 | 1.2 | 6.1 | 2.0 | 5.1 | 1.2 | 2.8 | 0.3 |
| December 22 | 8.6 | 2.0 | 6.3 | 0.2 | 6.2 | 1.1 | 3.5 | 0.7 |
| December 23 | 11.7 | 3.1 | 8.2 | 1.9 | 9.2 | 3.0 | 4.8 | 1.3 |
| December 24 | 15.4 | 3.7 | 11.0 | 2.8 | 11.2 | 2.0 | 5.6 | 0.8 |
| December 25 | 20.7 | 5.3 | 14.1 | 3.1 | 15.0 | 3.8 | 7.8 | 2.2 |
| December 26 | 22.9 | 2.2 | 17.1 | 3.0 | 19.1 | 4.1 | 10.6 | 2.8 |
| December 27 | 26.6 | 3.7 | 19.2 | 2.1 | 21.9 | 2.8 | 12.7 | 2.1 |
| December 28 | 27.6 | 1.0 | 21.2 | 2.0 | 24.0 | 2.1 | 14.9 | 2.2 |
| December 29 | 29.7 | 2.1 | 23.6 | 2.4 | 26.3 | 2.3 | 17.1 | 2.2 |
| December 30 | 32.5 | 2.8 | 25.4 | 1.8 | 27.2 | 0.9 | 19.7 | 2.5 |
| December 31 | 34.5 | 2.0 | 27.0 | 1.6 | 31.3 | 4.1 | 22.3 | 2.6 |
| **1934** | | | | | | | | |
| January 1 | 35.2 | 0.7 | 28.4 | 1.4 | 34.0 | 2.7 | 23.7 | 1.4 |
| January 2 | 37.7 | 2.5 | 29.4 | 1.0 | 35.0 | 1.0 | 25.4 | 1.7 |
| January 3 | 38.4 | 0.7 | 30.1 | 0.7 | 36.4 | 1.4 | 26.9 | 1.5 |
| January 4 | 38.7 | 0.3 | 30.8 | 0.7 | 36.7 | 0.3 | 28.0 | 1.1 |
| January 5 | 39.6 | 0.9 | 31.1 | 0.3 | 37.0 | 0.3 | 29.0 | 1.0 |
| January 6 | 39.7 | 0.1 | 31.6 | 0.5 | 37.3 | 0.3 | 29.8 | 0.8 |
| January 7 | 39.9 | 0.2 | 31.7 | 0.1 | 37.4 | 0.1 | 30.0 | 0.2 |
| January 8 | 39.9 | ------ | 31.8 | 0.1 | 37.5 | 0.1 | 30.3 | 0.3 |
| January 9 | ------ | ------ | 31.8 | ------ | 37.6 | 0.1 | 30.4 | 0.1 |
| January 10 | ------ | ------ | ------ | ------ | 37.8 | 0.2 | 30.7 | 0.3 |
| January 11 | ------ | ------ | ------ | ------ | 37.8 | ------ | 30.7 | ------ |
| Total | 39.0 | | 31.1 | | 37.3 | | 30.2 | |
| Average | 1.63 | | 1.24 | | 1.38 | | 1.12 | |

M—Stands for measurement.
G—Stands for growth.

TABLE 2.—*Showing the number of florets opening at different hours of the day*

| Time | Panicle number | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| | P | I | P | I | P | I | P | I | P | I | P | I |
| 6 p. m.–6 a. m. | 365 | 207 | 257 | 213 | 140 | 140 | 246 | 178 | 350 | 314 | 367 | 209 |
| 6 a. m.–7 a. m. | | | 2 | 4 | | | 1 | 3 | 4 | 28 | | |
| 7 a. m.–8 a. m. | 3 | 1 | | | | 4 | 1 | 11 | 3 | 1 | 1 | |
| 8 a. m.–9 a. m. | 19 | 20 | 4 | 13 | | 3 | 3 | 8 | | | 21 | 24 |
| 9 a. m.–10 a. m. | 28 | 12 | 1 | | | | 2 | 8 | 14 | 3 | 30 | 16 |
| 10 a. m.–11 a. m. | 32 | 20 | 10 | 24 | 8 | 6 | 17 | 6 | 17 | 12 | 33 | 21 |
| 11 a. m.–12 noon | 17 | 4 | 22 | 24 | 5 | 13 | 11 | 24 | 32 | 63 | 17 | 5 |
| 12 noon–1 p. m. | 21 | 25 | 10 | 2 | 6 | 6 | 10 | 6 | 12 | 3 | 23 | 27 |
| 1 p. m.–2 p. m. | 10 | 27 | 16 | 27 | | 11 | 5 | 14 | 28 | 15 | 12 | 29 |
| 2 p. m.–3 p. m. | 13 | 10 | 2 | 5 | 4 | | 1 | 19 | 11 | | 13 | 11 |
| 3 p. m.–4 p. m. | 18 | 19 | 7 | 9 | 1 | 5 | 16 | 11 | 15 | 33 | 17 | 18 |
| 4 p. m.–5 p. m. | 19 | 9 | 54 | 14 | 24 | 2 | 12 | 19 | 21 | 13 | 21 | 11 |
| 5 p. m.–6 p. m. | 14 | 5 | 4 | 3 | 4 | 3 | 2 | 1 | 2 | 7 | 12 | 3 |
| 6 a. m.–6 p. m. | 194 | 152 | 132 | 125 | 52 | 53 | 81 | 130 | 159 | 178 | 200 | 155 |

| Time | Panicle number | | | | | | | | Total | | Average | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | | 8 | | 9 | | 10 | | | | | |
| | P | I | P | I | P | I | P | I | P | I | P | I |
| 6 p. m. 6 a. m. | 136 | 130 | 351 | 299 | 260 | 217 | 256 | 189 | 2,728 | 2,096 | 272.8 | 209.6 |
| 6 a. m.–7 a. m. | | | 3 | 30 | 5 | 7 | 2 | 3 | 17 | 75 | 1.7 | 7.5 |
| 7 a. m.–8 a. m. | | 6 | 3 | 2 | 1 | 3 | 11 | 21 | 23 | 49 | 2.3 | 4.9 |
| 8 a. m.–9 a. m. | 2 | 5 | | 3 | 7 | 15 | 8 | 13 | 64 | 104 | 6.4 | 10.4 |
| 9 a. m.–10 a. m. | | 1 | 15 | 7 | 2 | 1 | 12 | 18 | 104 | 66 | 10.4 | 6.6 |
| 10 a. m.–11 a. m. | 9 | 6 | 19 | 12 | 12 | 27 | 22 | 11 | 179 | 145 | 17.9 | 14.5 |
| 11 a. m.–12 noon | 7 | 15 | 32 | 71 | 25 | 27 | 16 | 29 | 184 | 275 | 18.4 | 27.5 |
| 12 noon–1 p. m. | 8 | 7 | 13 | 6 | 12 | 5 | 10 | 5 | 125 | 92 | 12.5 | 9.2 |
| 1 p. m.–2 p. m. | 2 | 11 | 25 | 13 | 16 | 28 | 4 | 13 | 118 | 188 | 11.8 | 18.8 |
| 2 p. m.–3 p. m. | 6 | | 12 | 3 | 3 | 6 | | 18 | 65 | 72 | 6.5 | 7.2 |
| 3 p. m.–4 p. m. | 3 | 8 | 18 | 35 | 9 | 11 | 17 | 12 | 121 | 161 | 12.1 | 16.1 |
| 4 p. m.–5 p. m. | 23 | 4 | 25 | 13 | 59 | 17 | 10 | 17 | 268 | 119 | 26.8 | 11.9 |
| 5 p. m.–6 p. m. | 6 | 4 | 4 | 9 | 3 | 2 | 5 | 4 | 56 | 41 | 5.6 | 4.1 |
| 6 a. m.–6 p. m. | 66 | 67 | 169 | 204 | 154 | 149 | 117 | 164 | 1,324 | 1,387 | 132.4 | 138.7 |

NOTE.—P stands for perfect florets. I stands for imperfect florets.

The fourth division was sprayed with calcium arsenate at the concentration of nine level spoonfuls for every petroleum canful of tap-water. The spray was continually stirred while it was being applied.

It was noticed two days after the operation that the rachises of the flowers showed signs of burning. The concentration was, therefore, reduced to five level spoonfuls for every petroleum canful of water in the succeeding tests and applications.

Dry lime sulphur at the dilution of seven level spoonfuls for every five gallons of water was sprayed thoroughly to one division. The spray was stirred continuously while it was being applied in a fine mist.

Another section was carefully sprayed with soap solution which was prepared by dissolving 40 grams of chip soap (from the Bureau's stock) in a petroleum canful of water. To this solution was added four teaspoonfuls of Black Leaf "40" (nicotine sulphate). The spray was applied in fine mists with the aid of a well adjusted nozzle.

The last division was treated with Fungi-bordo. The spray was prepared by disolving ten level spoonfuls of the Fungi-Bordo powder to a five gallons of water. It was vigorously stirred before the application and the stirring continued during the spraying.

Each of the selected experimental trees was sprayed in the same manner as described.

The whole spraying operation was repeated after every four days until all the experimental flowers had passed the fertilization period. Care was exercised that the sections or divisions always received the same spray as they got in the first application.

During the course of the study, enormous number of mango leaf-hoppers attacked the newly fertilized flowers. With the view of minimizing the damages of the insects, which may cause the entire failure of the crop at the station, the soap solution plus nicotine sulphate spray was applied thoroughly to all parts of the experimental trees, including the control sections, every other day. Some nearby trees were also sprayed. The spray against the hoppers was continued regularly until the fruits were about the size of a pea seed. Spraying was only occasional after then. Aside from the factors or variables under consideration, all the sections were treated as uniformly as possible.

When most of the fruits were about an inch long, they were carefully counted and recorded separately with the use of a hand tally-counter, for each section. The results are presented in Table 6.

Because of the interference of the mango leaf-hoppers and the desire to verify the data, the experiment was repeated during the 1935–36 smudging season. This time the trees did not flower so heavily as in the previous season. The flowers were produced in patches in the crowns. For this reason, the crowns were not divided in the same number as the previous experimental trees but were only divided into halves. One half was control and the other was treated with a variable. Five trees were selected. Because of the deleterious effect on the flowers of the calcium arsenate at the concentration tried, as observed in the first three tests (Table 6), this spray was not included in the trial in 1935–36.

The mango leaf-hoppers did not cause much trouble during the progress of this study.

Spraying was done much earlier than the experiments conducted during the 1934–35 seasons. When the buds showed signs of activity as a result of smudging, the divisions were sprayed at once with the treatment intended for each of them. The treatment was carried at weekly intervals until the flowers began to open, at which time the procedure followed during the previous season was precisely adopted. The number of panicles under treatment or division was taken when the inflorescences were most conspicuous, i. e., when most of the florets were in their fertilization period. The number of fruits was recorded when most of them were about one inch long. Table 6a shows the results obtained from the 1935–36 trial.

## DISCUSSION OF RESULTS

*Carabao mango flowers.*—A study of Table 1 together with Chart 1 shows that the panicles exposed to sunshine had greater growth than those which were shaded. This was true on inflorescences born both by the terminal and lateral twigs. The average daily elongation of the terminal inflorescences was 1.63 and 1.24 cm. for those exposed to the sunshine and shaded from the direct sun rays, respectively. The lateral flower panicles in the open made an average daily growth of 1.38 cm. in length and 1.12 cm. for the shaded ones (Table 1).

In general the rate of elongation of the Carabao mango inflorescence was rather slow at the beginning, but it gradually increased up to about the fifteenth day of their growth when 5.3, 3.1, 4.1, and 2.8 cm. was attained by the terminal open, terminal shaded, lateral open, and lateral shaded inflorescences, respectively, as may be seen in Chart 1. In fact it may be of interest to mention that this behavior of the mango buds is one of the criteria of mango smudgers in distinguishing flowers from shoots when the growth is only a few millimeters long. Generally the leaf-buds grow much faster than the flower buds. After about fifteen days, the growth decreased gradually until it finally ceased when the floret at the tip had fully developed, which was after about another fifteen days more.

The differences in the daily elongation of the panicles in the different conditions were small, but considering that they grew for 28 to 31 days the difference may reach up to 7.80 to 10.92 cm. which means a lot of florets in favor of the flower panicles exposed to direct sunshine. The difference was of course obviously accountable to the greater photosynthetic activity in those parts of the plants.

It was observed that more florets opened at night than at day time. From 6 p. m. to 6 a. m. 272.8 perfect and 209.6 imperfect (male) florets opened while 132.4 perfect and 138.7 male florets opened from 6 a. m. to 6 p. m. (Table 2 and Chart 2). From 6 a. m. to 7 a. m., an average of 1.7 perfect florets per panicle had opened. The number of florets that opened during each succeeding hour increased rapidly up to 18.4 florets at 11 a. m. to 12 noon, diminished down to 6.5 florets at 2 to 3 p. m. and soaring again sharply reaching the maximum of 26.8 opened florets at 4 to 5 p. m. From that time the number abruptly dropped to 5.6 at the next hour (Table 2).

The trend of opening of the male florets followed closely the curve of the perfect florets with the difference that the maximum male florets opened at 11 a. m. to 12 noon while that of the perfect was at 4 to 5 p. m. (Chart 2).

Table 3 shows that all the florets in a Carabao mango panicle opened after 12 to 18 days or an average of 15.16 ± 0.20 days from the time the first floret in the panicle opened. Most of the perfect florets in the panicle (more than 76 per cent) opened from the third to the eighth day. From the first to the eighth day, many more perfect florets opened than male florets. However, from the ninth to the last day more male than

TABLE 3.—*Showing the number of florets opening daily in a Carabao mango flower panicle*

| Panicle number | Number of florets opening on the— | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st day | | 2nd day | | 3rd day | | 4th day | | 5th day | | 6th day | |
| | P | I | P | I | P | I | P | I | P | I | P | I |
| 1 | 3 | | 11 | | 38 | 3 | 110 | 7 | 137 | 29 | 146 | 58 |
| 2 | 4 | | 20 | | 45 | 2 | 94 | 7 | 77 | 18 | 71 | 36 |
| 3 | 2 | | 10 | 2 | 22 | 1 | 51 | 7 | 39 | 7 | 31 | 18 |
| 4 | 11 | | 23 | 2 | 56 | 3 | 60 | 16 | 78 | 25 | 33 | 52 |
| 5 | 14 | | 44 | 7 | 83 | 13 | 115 | 19 | 98 | 64 | 81 | 112 |
| 6 | 2 | 1 | | | 40 | 15 | 67 | 35 | 103 | 65 | 111 | 51 |
| 7 | 9 | | 57 | 2 | 66 | 3 | 93 | 6 | 135 | 35 | 170 | 36 |
| 8 | 4 | | 7 | | 37 | 1 | 36 | 4 | 64 | 9 | 96 | 35 |
| 9 | 26 | 2 | 62 | 11 | 57 | 14 | 104 | 13 | 105 | 80 | 110 | 63 |
| 10 | 20 | 3 | 49 | 7 | 54 | 7 | 76 | 17 | 108 | 12 | 90 | 37 |
| 11 | 5 | 1 | 43 | 6 | 47 | 8 | 101 | 12 | 115 | 15 | 122 | 26 |
| 12 | 2 | | 31 | 5 | 54 | 2 | 60 | 10 | 118 | 7 | 87 | 10 |
| 13 | 7 | | 23 | | 61 | 3 | 70 | 4 | 127 | 34 | 77 | 33 |
| 14 | 7 | | 31 | 2 | 41 | 2 | 56 | 3 | 70 | 15 | 108 | 35 |
| 15 | 7 | 1 | 45 | 4 | 70 | 3 | 72 | 8 | 120 | 21 | 143 | 31 |
| 16 | 3 | | 43 | | 74 | 7 | 133 | 11 | 73 | 2 | 204 | 45 |
| 17 | 4 | | 17 | 2 | 45 | 2 | 140 | 17 | 130 | 45 | 100 | 20 |
| 18 | 11 | 1 | 57 | 8 | 145 | 49 | 193 | 23 | 66 | 20 | 86 | 40 |
| 19 | 5 | 7 | 18 | 6 | 95 | 14 | 81 | 16 | 12 | 10 | 81 | 25 |
| 20 | 5 | | 24 | 6 | 64 | 10 | 91 | 18 | 119 | 80 | 125 | 50 |
| 21 | 3 | | 22 | 2 | 40 | 6 | 24 | 8 | 50 | 34 | 15 | 7 |
| 22 | 6 | 5 | 24 | 29 | 36 | 4 | 20 | 8 | 12 | 15 | 19 | 18 |
| 23 | 8 | | 17 | 4 | 77 | 10 | 110 | 18 | 100 | 39 | 98 | 36 |
| 24 | 4 | | 24 | 5 | 65 | 4 | 33 | 24 | 39 | 46 | 125 | 85 |
| 25 | 9 | | 90 | 12 | 145 | 47 | 322 | 352 | 224 | 99 | 182 | 112 |
| Total | 181 | 21 | 792 | 122 | 1,557 | 233 | 2,312 | 663 | 2,369 | 826 | 2,511 | 1,071 |
| Average | 7.24 | 0.84 | 31.68 | 4.88 | 62.28 | 9.32 | 92.48 | 26.52 | 94.76 | 33.04 | 100.44 | 42.84 |

TABLE 3.—*Showing the number of florets, etc.*—Continued.

| Panicle number | Number of florets opening on the— | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7th day | | 8th day | | 9th day | | 10th day | | 11th day | | 12th day | |
| | P | I | P | I | P | I | P | I | P | I | P | I |
| 1 | 68 | 113 | 25 | 59 | 16 | 55 | 5 | 24 | ------ | 6 | ------ | 5 |
| 2 | 32 | 64 | 23 | 43 | 7 | 64 | 7 | 55 | 3 | 26 | 2 | 16 |
| 3 | 24 | 35 | 7 | 25 | 2 | 47 | 1 | 24 | 3 | 14 | ------ | 10 |
| 4 | 32 | 37 | 32 | 64 | 4 | 54 | 7 | 30 | 5 | 15 | 2 | 2 |
| 5 | 27 | 118 | 12 | 77 | 4 | 44 | 2 | 30 | ------ | 8 | 1 | 1 |
| 6 | 130 | 102 | 100 | 150 | 66 | 180 | 44 | 81 | 49 | 111 | 78 | 38 |
| 7 | 119 | 71 | 81 | 88 | 34 | 58 | 15 | 44 | 13 | 23 | 4 | 28 |
| 8 | 119 | 30 | 100 | 54 | 106 | 68 | 52 | 48 | 46 | 60 | 23 | 30 |
| 9 | 50 | 79 | 45 | 60 | 12 | 18 | 7 | 21 | 6 | 14 | 1 | 3 |
| 10 | 43 | 17 | 24 | 26 | 7 | 4 | 7 | 8 | 5 | 12 | 5 | 6 |
| 11 | 71 | 58 | 103 | 84 | 29 | 75 | 46 | 58 | 38 | 32 | 29 | 29 |
| 12 | 73 | 96 | 44 | 55 | 52 | 78 | 15 | 25 | 21 | 24 | 11 | 12 |
| 13 | 150 | 91 | 63 | 74 | 22 | 112 | 50 | 42 | 31 | 29 | 21 | 35 |
| 14 | 90 | 96 | 65 | 58 | 77 | 67 | 51 | 26 | 33 | 44 | 14 | 18 |
| 15 | 85 | 66 | 136 | 105 | 54 | 54 | 47 | 61 | 48 | 49 | 21 | 25 |
| 16 | 101 | 51 | 88 | 62 | 43 | 63 | 34 | 36 | 12 | 19 | 12 | 4 |
| 17 | 67 | 50 | 42 | 36 | 30 | 35 | 56 | 15 | 5 | 40 | 45 | 25 |
| 18 | 25 | 41 | 25 | 36 | 15 | 27 | 12 | 30 | 18 | 4 | 25 | 5 |
| 19 | 64 | 48 | 50 | 17 | 37 | 12 | 16 | 20 | 8 | 3 | 5 | 3 |
| 20 | 165 | 58 | 110 | 42 | 130 | 89 | 70 | 85 | 70 | 91 | 48 | 57 |
| 21 | 18 | 2 | 5 | 8 | 5 | 2 | 5 | 2 | 15 | 38 | 10 | 31 |
| 22 | 30 | 25 | 24 | 3 | 40 | 8 | 18 | 3 | 30 | 20 | 5 | 9 |
| 23 | 200 | 81 | 182 | 34 | 48 | 18 | 2 | 34 | 35 | 82 | 12 | 64 |
| 24 | 7 | 115 | 26 | 15 | 2 | 5 | 3 | 20 | 2 | 15 | ------ | 5 |
| 25 | 124 | 36 | 79 | 60 | 68 | 63 | 36 | 28 | 28 | 13 | 39 | 7 |
| Total | 1,914 | 1,580 | 1.491 | 1,335 | 960 | 1,299 | 608 | 850 | 524 | 792 | 413 | 468 |
| Average | 76.56 | 63.20 | 59.64 | 53.40 | 38.40 | 51.96 | 24.32 | 34.00 | 20.96 | 31.68 | 16.52 | 18.72 |

| Panicle number | Number of florets opening on the— | | | | | | | | | | | | Number of days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13th day | | 14th day | | 15th day | | 16th day | | 17th day | | 18th day | | |
| | P | I | P | I | P | I | P | I | P | I | P | I | |
| 1 | | | | | | | | | | | | | 12 |
| 2 | 1 | 5 | 4 | | | | | | | | | | 14 |
| 3 | | 2 | | | | | | 1 | | | | | 16 |
| 4 | 2 | 4 | | | | | | | | | | | 13 |
| 5 | | 1 | | 1 | | | | | | | | | 14 |
| 6 | 9 | 30 | 5 | 15 | 5 | 4 | 4 | 1 | 1 | 1 | | | 17 |
| 7 | | 10 | 1 | 3 | | | | | | | | | 14 |
| 8 | 10 | 8 | 6 | 9 | 2 | 3 | 2 | | | | 1 | | 18 |
| 9 | 1 | 3 | | 1 | | | | | | | | | 14 |
| 10 | 5 | 1 | 1 | 1 | | | | 1 | | | | | 16 |
| 11 | 22 | 23 | 13 | 7 | 6 | 4 | 1 | | 1 | | | | 17 |
| 12 | 5 | 9 | 5 | 2 | 3 | 1 | | | 1 | | | | 17 |
| 13 | 3 | 11 | 1 | 14 | 2 | 1 | 1 | 1 | | | | | 16 |
| 14 | 18 | 15 | 8 | 15 | 7 | 3 | 2 | 1 | | 2 | | | 17 |
| 15 | 18 | 17 | 10 | 8 | 1 | 6 | | | | | | | 15 |
| 16 | 12 | 4 | 4 | 3 | 3 | 2 | | | | | | | 15 |
| 17 | 2 | 1 | 7 | 38 | | | | | | | | | 14 |
| 18 | 20 | | | 1 | | 5 | | | | | | | 15 |
| 19 | 4 | 12 | 5 | 5 | | 5 | | | | | | | 15 |
| 20 | 30 | 23 | 2 | 6 | | 2 | | | | | | | 15 |
| 21 | 3 | 5 | 1 | 1 | | 1 | | | | | | | 15 |
| 22 | 10 | 18 | 4 | 25 | 1 | 4 | | 1 | | | | | 16 |
| 23 | 10 | 35 | 3 | 7 | | | | | | | | | 14 |
| 24 | 1 | 1 | | 1 | 1 | 1 | | | | | | | 15 |
| 25 | 4 | 15 | 2 | 1 | 1 | 2 | | | | | | | 15 |
| Total | 190 | 253 | 82 | 164 | 32 | 44 | 10 | 6 | 3 | 3 | 1 | | 379 |
| Average | 7.60 | 10.12 | 3.28 | 6.56 | 1.28 | 1.76 | 0.40 | 0.24 | 0.12 | 0.12 | 0.04 | | 15.16 ± .20 |

TABLE 4.—*Showing the length of time it takes the anthers of Carabao mango florets to open*

| Date | Floret No. | Time the anthers— Begin to open | Time the anthers— Fully open | Time the anthers open |
|---|---|---|---|---|
| 1934 | | | | *min.* |
| January 6 | 1 | 7.25 a. m. | 7.34 a. m. | 9.0 |
| January 6 | 2 | 8.005 a. m. | 8.09 a. m. | 8.5 |
| January 6 | 3 | 8.105 a. m. | 8.19 a. m. | 8.5 |
| January 6 | 4 | 8.005 a. m. | 8.10 a. m. | 9.5 |
| January 6 | 5 | 8.23 a. m. | 8.31 a. m. | 8.0 |
| January 6 | 6 | 8.31 a. m. | 8.39 a. m. | 8.0 |
| January 6 | 7 | 8.35 a. m. | 8.44 a. m. | 9.0 |
| January 6 | 8 | 8.42 a. m. | 8.51 a. m. | 9.0 |
| January 6 | 9 | 8.45 a. m. | 8.54 a. m. | 9.0 |
| January 6 | 10 | 9.11 a. m. | 9.20 a. m. | 9.0 |
| January 6 | 11 | 9.28 a. m. | 9.365 a. m. | 8.5 |
| January 6 | 12 | 10.48 a. m. | 10.56 a. m. | 8.0 |
| January 6 | 13 | 11.05 a. m. | 11.13 a. m. | 8.0 |
| January 6 | 14 | 11.27 a. m. | 11.35 a. m. | 8.0 |
| January 6 | 15 | 11.39 a. m. | 11.47 a. m. | 8.0 |
| January 6 | 16 | 12.51 p. m. | 12.575 p. m. | 6.5 |
| January 6 | 17 | 12.55 p. m. | 1.03 p. m. | 8.0 |
| January 7 | 18 | 7.35 a. m. | 7.44 a. m. | 9.0 |
| January 7 | 19 | 7.42 a. m. | 7.51 a. m. | 9.0 |
| January 7 | 20 | 8.28 a. m. | 8.375 a. m. | 9.5 |
| January 7 | 21 | 9.11 a. m. | 9.19 a. m. | 8.0 |
| January 7 | 22 | 9.30 a. m. | 9.39 a. m. | 9.0 |
| January 7 | 23 | 9.50 a. m. | 9.59 a. m. | 9.0 |
| January 7 | 24 | 10.15 a. m. | 10.25 a. m. | 10.0 |
| January 7 | 25 | 10.40 a. m. | 10.48 a. m. | 8.0 |
| January 7 | 26 | 11.10 a. m. | 11.19 a. m. | 9.0 |
| January 7 | 27 | 11.46 a. m. | 11.54 a. m. | 8.0 |
| January 7 | 28 | 12.45 p. m. | 12.51 p. m. | 6.0 |
| January 7 | 29 | 12.58 p. m. | 1.055 p. m. | 7.5 |
| January 8 | 30 | 7.03 a. m. | 7.11 a. m. | 8.0 |
| January 8 | 31 | 7.28 a. m. | 7.39 a. m. | 11.0 |
| January 8 | 32 | 7.45 a. m. | 7.54 a. m. | 9.0 |
| January 8 | 33 | 8.30 a. m. | 8.39 a. m. | 9.0 |
| January 8 | 34 | 9.43 a. m. | 9.525 a. m. | 9.5 |
| January 8 | 35 | 9.57 a. m. | 10.06 a. m. | 9.0 |
| January 8 | 36 | 10.25 a. m. | 10.32 a. m. | 7.0 |
| January 8 | 37 | 11.40 a. m. | 11.48 a. m. | 8.0 |
| January 8 | 38 | 12.18 p. m. | 12.265 p. m. | 8.5 |
| January 9 | 39 | 9.15 a. m. | 9.24 a. m. | 9.0 |
| January 9 | 40 | 9.40 a. m. | 9.48 a. m. | 8.0 |
| January 9 | 41 | 10.30 a. m. | 10.38 a. m. | 8.0 |
| January 9 | 42 | 11.15 a. m. | 11.23 a. m. | 8.0 |
| January 9 | 43 | 12.05 p. m. | 12.125 p. m. | 7.5 |
| January 9 | 44 | 12.09 p. m. | 12.16 p. m. | 7.0 |
| January 10 | 45 | 8.05 a. m. | 8.14 a. m. | 9.0 |
| January 10 | 46 | 9.25 a. m. | 9.35 a. m. | 10.0 |
| January 10 | 47 | 10.12 a. m. | 10.20 a. m. | 8.0 |
| January 10 | 48 | 11.50 a. m. | 11.56 a. m. | 6.0 |
| January 10 | 49 | 12.01 p. m. | 12.08 p. m. | 7.0 |
| Total | 49 | | | 411.0 |
| Average | 1 | | | 8.39 |
| P. E. of Mean | | | | ±0.09 |

perfect florets had opened (Chart 3). The fact that most of the perfect florets are located at the middle of the tips of the rachises perhaps this explains why most of them opened somewhat earlier than most of the male florets and also confirms the observation that the fruits of Carabao mango were born mostly at points from the middle to the tip of the rachises. Considering all other factors equal it may be stated in passing that with the greater number of male flowers more pollen-grains are produced and consequently a greater chance of pollination because of the greater proportion of male to female florets.

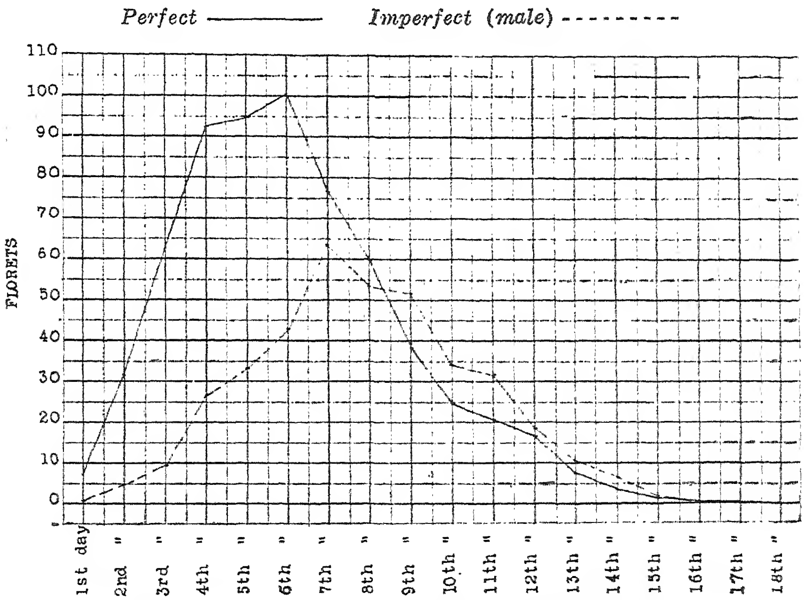


CHART 3. Trend of opening of perfect and imperfect florets

While dealing in the question of pollination, the nature of dehiscence was considered and it was observed that the Carabao mango anthers did not dehisced in a snap as in some plants but on the contrary, rather slowly. From the moment the suture began to open which was readily observed with the aid of a hand lens, until the time the lids of the anther had completely turned inside out it took 8.39 ± 0.09 minutes (Table 4). At first the opening of the suture was very slow until more or less two-thirds of the length had separated and turned inside out at a comparatively faster rate and then continued on the process slowly. A completely dehisced anther suggested the shape of a very tiny kidney with ashen-gray color. A Carabao

mango anther was pinkish light violet becoming slightly darker or violet red as it was about ready to dehisce.

Table 5 shows that a Carabao mango flower panicle, depending upon the size, had from 363 to as high as 2,200 or an average of 1,009.63 ± 54.01 individual florets. Of this figure, 216 to 1,353 with 631.07 ± 33.51 average or 62.51 per cent were perfect. From this it could be readily seen that even only one per cent would develop into fruits and allowing further one-half of the set for natural fall and the destructive agencies there would still be an excellent crop because in such a case more than three fruits would yet mature in each panicle.

TABLE 5.—*Showing the number of florets in a Carabao mango flower panicle*

| Panicle No. | Number of— | | Total number of florets in the flower panicle |
|---|---|---|---|
| | Perfect florets | Imperfect florets | |
| 1 | 1,353 | 847 | 2,200 |
| 2 | 588 | 282 | 870 |
| 3 | 690 | 326 | 1,016 |
| 4 | 698 | 290 | 988 |
| 5 | 481 | 203 | 684 |
| 6 | 1,053 | 617 | 1,670 |
| 7 | 420 | 356 | 776 |
| 8 | 220 | 213 | 433 |
| 9 | 378 | 314 | 692 |
| 10 | 507 | 541 | 1,048 |
| 11 | 839 | 315 | 1,154 |
| 12 | 216 | 147 | 363 |
| 13 | 279 | 195 | 474 |
| 14 | 390 | 103 | 493 |
| 15 | 847 | 466 | 1,313 |
| 16 | 396 | 342 | 738 |
| 17 | 804 | 879 | 1,683 |
| 18 | 787 | 407 | 1,194 |
| 19 | 711 | 359 | 1,070 |
| 20 | 586 | 382 | 968 |
| 21 | 494 | 162 | 656 |
| 22 | 793 | 435 | 1,228 |
| 23 | 582 | 336 | 918 |
| 24 | 809 | 484 | 1,293 |
| 25 | 682 | 402 | 1,084 |
| 26 | 877 | 459 | 1,336 |
| 27 | 559 | 359 | 918 |
| Maximum | 1,353 | 879 | 2,200 |
| Minimum | 216 | 103 | 363 |
| Total | 17,039 | 10,221 | 27,260 |
| Average | 631.07 | 378.55 | 1,009.63 |
| P. E. mean | ±33.51 | ±23.96 | ±54.01 |
| Percentage | 62.51 | 37.49 | 100.00 |

The male florets of Carabao mango flower were observed to be 37.49 per cent, ranging from 103 to 879 per panicle of flowers.

Figure 1 shows an enlarged drawing of a perfect floret. As described by Popenoe(3) it is subsessile. It has five ovate-lanceolate concave sepals which are covered with fine pubescence. The short pedicel together with the calyx is pale green.

The corolla is composed of five ovate-lanceolate petals which are white at the margin and turning yellow toward the central base. The corolla is inserted at the base of a fleshy and vaguely lobed slightly flattened globose disk. On the disk is obliquely placed spherical pale yellow ovary which is provided with a very slightly tapering about three milimeters long style, ending at an almost needle-point-like stigma. At the side opposite the inclination of the style is a violet red anther borne by a slender filament. Although the usual number of stamens is five, only one or two stamens develop properly to bear pollen-grains. The rest are only staminodes.

The male floret is in all cases similar to the perfect floret with the exception of the absence of the pistil in the male floret. The anthers are then borne at the center of the disk (Fig. 2).

The characteristics of the Carabao mango flower show that they are insect-pollinated. The almost needle-point-like stigma, the relative positions of the anther and stigma, the mode of dehiscence of the anthers, and the cohesive tendency of the pollen-grains indicate that it is entomophilous.

*Spraying experiments.*—Table 6 shows the results of the spraying experiments conducted during the 1934–35 smudging season. As already stated elsewhere in this paper, the mango hoppers were extraordinarily abundant during the season and great damage was suffered by the crops. Most of the flowers were ruined by the insects, so that the percentages of setting were very much below normal, in spite of the fact that the sets obtained were beyond expectation, considering the abundance of the pests and the total ruin of the flowers in the neighboring trees which were not sprayed. The spray against the insects was always applied in the afternoon because it was observed that very negligible number of anthers dehisced in the late afternoon. The spray therefore unless it was too concentrated to adversely affect the flowers, did not interfere very much in the pollinating activities of the beneficial insects. However, it was noticed that there were again hoppers in the sprayed trees the following morning. Most of them must have come from the unsprayed trees while the rest might have escaped from the effect of the spray.

It appeared that the calcium arsenate with the concentration used was rather strong for the flowers. Signs of burning were observed soon after the first spraying so that in the succeeding application the concentration was lowered. Even at this the percentages of setting was so low that of the 740,875 perfect florets treated with calcium arsenate only six fruits or 0.00082 per cent set was obtained. One-half per cent lead arsenate spray was also observed by Palo and Garcia(2) to be toxic on the open flowers.

In the case of the Black Leaf "40" plus soap, 478,981 perfect florets contained in 759 panicles were sprayed. Of this number, 109 fruits set, which was 0.05478 per cent was obtained. This was second highest percentage of setting secured during the season. This was also true in the test carried during the 1935–36 smudging season, 0.19416 per cent having been obtained (Table

TABLE 6.—*Showing the effects of certain sprays, rain and tap-water on the fruit setting of Carabao mango flowers. (1934–1935 season.)*

| Test number | Treatment | Number of panicles treated | Estimated number of perfect florets treated [a] | Number of fruits set | Percentage of fruits set | Average percentage of setting |
|---|---|---|---|---|---|---|
| 1 | Calcium arsenate | 502 | 316,797 | 2 | 0.00063 | |
| 2 | Calcium arsenate | 328 | 206,990 | 0 | 0.00000 | 0.00082 |
| 3 | Calcium arsenate | 344 | 217,088 | 4 | 0.00184 | |
| 1 | Black leaf "40" | 257 | 162,184 | 52 | 0.03206 | |
| 2 | Black leaf "40" | 442 | 278,933 | 8 | 0.00287 | 0.05478 |
| 3 | Black leaf "40" | 60 | 37,864 | 49 | 0.12941 | |
| 1 | Fungi-bordo | 427 | 269,467 | 17 | 0.00631 | |
| 2 | Fungi-bordo | 198 | 124,952 | 6 | 0.00480 | 0.00947 |
| 3 | Fungi-bordo | 110 | 69,418 | 12 | 0.01729 | |
| 1 | Lime sulphur | 273 | 172,282 | 53 | 0.03076 | |
| 2 | Lime sulphur | 464 | 292,816 | 0 | 0.00000 | 0.06389 |
| 3 | Lime sulphur | 65 | 41,020 | 66 | 0.16090 | |
| 1 | Rain water | 558 | 352,137 | 63 | 0.01789 | |
| 2 | Rain water | 478 | 301,651 | 21 | 0.00696 | 0.02023 |
| 3 | Rain water | 115 | 72,573 | 26 | 0.03583 | |
| 1 | Tap-water | 403 | 254,321 | 5 | 0.00197 | |
| 2 | Tap-water | 398 | 251,166 | 3 | 0.00119 | 0.00469 |
| 3 | Tap-water | 901 | 568,594 | 62 | 0.01090 | |
| 1 | Control | 496 | 213,011 | 32 | 0.01502 | |
| 2 | Control | 350 | 220,874 | 27 | 0.01222 | 0.02745 |
| 3 | Control | 115 | 72,573 | 40 | 0.05512 | |

[a] Estimate was based on 631.07 perfect florets for each panicle as per Table 5.

6a). The spray helped in minimizing the injury of the leaf-hoppers although they were not seriously dangerous in number in the latter season.

The sections treated with Fungi-bordo had 735 flower panicles with 463,837 perfect florets. Only 35 fruits were realized, thus giving an average of 0.00947 per cent setting. This treatment although it gave proportionately more fruits than what was obtained in the calcium arsenate treated sections, was lower than the average setting of the untreated sections. The same sort of results were obtained in the experiment carried in the 1935–36 season.

Lime sulphur gave the best results of this spraying study. Of the 802 panicles having 506,118 perfect florets, 119 fruits set, giving an average of 0.06389 per cent setting, in spite of the fact that in the second test for this treatment no fruit was obtained. It may be mentioned that the second test during the season was started rather late so that the hoppers had already done considerable damage. In the study carried in 1935–36 season, a difference of 0.07296 per cent over the control was obtained and this treatment was also the best among those tried during the season.

The sections sprayed with rain water had 1,151 panicles with perfect florets estimated to be 726,361. The average setting was 0.02023 which was 0.00722 per cent less than that of the control. However, this was very much higher than the setting

TABLE 6a.—*Showing the effects of certain sprays, rain and tap-water on the fruit setting of Carabao mango flowers. (1935–1936 season.)*

| Treatment | Number of panicles treated | Estimated number of perfect florets treated [a] | Number of fruits set | Percentage of fruits set | Difference |
|---|---|---|---|---|---|
| Black leaf "40" | 182 | 114,855 | 223 | 0.19416 | +0.01861 |
| Control | 269 | 169,758 | 298 | 0.17555 | |
| Fungi-bordo | 81 | 51,117 | 61 | 0.11933 | —0.08415 |
| Control | 88 | 55,534 | 113 | 0.20348 | |
| Lime sulphur | 92 | 58,058 | 91 | 0.15674 | +0.07296 |
| Control | 87 | 54,903 | 46 | 0.08378 | |
| Rain water | 118 | 74,466 | 99 | 0.13295 | —0.04259 |
| Control | 269 | 169,758 | 298 | 0.17554 | |
| Tap-water | 233 | 147,039 | 168 | 0.11423 | —0.03330 |
| Control | 319 | 201,311 | 297 | 0.14753 | |

[a] Estimate was based on 631.07 perfect florets for each panicle as per Table 5.

obtained in the calcium arsenate treatment. In the study carried out in the following smudging season, similar trend of

results were realized. This simply showed that the rain water itself was not the direct cause of the total failures of the mango blossom to set fruits. Rather it was due to lack of pollination which of course, rain was an important adverse factor. As stated by Palo and Garcia, "rain . . . impaired the activity of the pollinating insects so much that many of the flowers remained unfertilized." Popenoe believes that the mango pollen-grains have the tendency to cling together especially during damp weathers. Considering that the mango flowers' characteristics were observed to be more entomophilous rather than anemophilous, rain therefore was an important hindrance in the pollination of the mango flowers. Also it has been reported that rains and showery weathers render the development of the anthracnose disease to the optimum. Rain, therefore, should be regarded with serious concern in the setting of mango fruits in that it is a strong limiting factor in pollination, for it favors the attacks of anthracnose disease, aside from the physical injury which obviously strong and heavy rain imparts to the comparatively tiny and tender mango florets.

These results of observations more or less give an idea of the nature and cause of the indirect unfavorable effects of rains and showery weather. The problem, therefore, is how to counteract these effects. To control the weather condition is a difficult proposition. However, it is fortunate that the mango is amenable to smudging. This therefore could be taken advantage of by smudging the trees so that the pollinating period of the flowers should coincide with the dry weathers. Another way to go around the effect of bad weather is the breeding of certain varieties or strains whose flowers could set and develop fruits despite rain and humid conditions of the atmosphere. It is of interest to mention that some Indian mangos and the Huani (*Mangifera odorata* Grif.) have been observed to set fruits freely at Lamao, Bataan, even without smudging and in spite of rain or showery weather during their blooming periods.

Tap-water treatment gave an average of 0.00469 per cent from 1,074,081 perfect florets in 1,702 panicles. This was lower than the results obtained from the rain water treatment (Table 6). It was believed that the very limited ammonia from the air in the rain was undesirable with the flowers, but it was found from this study that the different organisms likely to be present in the tap-water perhaps made it worse than the rain to the flowers.

The effects of tap-water on the flowers may be said to be similar to that of the rain. But should spraying be necessary for the control of insect pests and diseases, it is suggested that it should be applied in the afternoon because it was observed that the greatest majority of the anthers dehisced in the morning. Very negligible number shed their pollens in the late afternoon. The anthers would have dried in the following morning when they dehisce, thus the activities of the pollinating insects would be least impaired.

## SUMMARY

1. This paper presents the results of some studies at Lamao, Bataan, on the Carabao mango flower and the effect of certain sprays, rain water and tap-water on the setting of fruits.

2. The average daily elongation of the terminal inflorescences was 1.63 and 1.24 cm. for those exposed to the sunshine and shaded from the direct sun rays, respectively.

3. The lateral flower panicles had 1.38 cm. daily growth in length for those open to the sun rays and 1.12 cm. for the shaded inflorescences.

4. The panicles exposed to the direct sunshine were 7.80 to 10.92 cm. longer than those which were shaded.

5. More florets opened between 6 p. m. to 6 a. m. than from 6 a. m. to 6 p. m. During the night, 272.8 perfect and 209.6 male florets opened while 132.4 perfect and 133.7 male florets opened during the day, or 23.01 and 19.54 per cent, respectively.

6. The greatest number of perfect florets (26.8) opened at 4 to 5 p. m. while in the case of the male florets the most number opened at 11 a. m. to 12 noon.

7. All the florets in a Carabao mango flower panicle opened from 12 to 18 days or an average of $15.16 \pm 0.20$ days from the time the first floret in the inflorescence opened; more than 76 per cent opening from the third to the eighth day.

8. The greatest number of the perfect florets open in the first 3 to 8 days while more of the male open in the later days.

9. The Carabao mango anthers did not open in a snap but very slowly, the whole operation taking place in $8.39 \pm 0.09$ minutes.

10. Depending upon the size of the panicle, each Carabao mango inflorescence had 363 to 2,200 florets, or an average of $1{,}009.63 \pm 54.01$ individual flowers.

11. There were 62.51 per cent perfect florets in a Carabao mango inflorescence.

12. The Carabao mango is polygamous and the characteristics indicated it to be entomophilous.

13. Calcium arsenate at the concentration of five to nine level spoonfuls for every petroleum canful of water had burning effect upon the open florets.

14. Four teaspoonfuls of Black Leaf "40" added to five gallons of soap solution prepared by disolving 40 grams of chip soap in a petroleum canful of water, gave the second highest percentage of setting among the sprays studied. The average setting obtained with this treatment was 0.05478 per cent for 1934–35 smudging season and 0.19416 per cent for 1935–36 season.

15. The section treated with Fungi-bordo gave 0.00947 per cent setting in the first season and 0.11933 per cent in the second. These were lower than the percentage setting of the control.

16. Lime-sulphur at the concentration of seven spoonfuls for every five gallons of water gave the highest percentage of setting in this observation. In both the 1934-35 and 1935-36 season trials, the treated sections gave 0.03644 and 0.07296 per cent higher than the control, respectively.

17. The sections treated with rain water and tap-water had fruit setting percentages lower than the control. Rain water and ordinary tap-water adversely affected pollination, more so with the latter treatment, but they were not observed to directly effect wholesale blighting of the flowers.

18. Spray of any sort was found detrimental to a certain degree to the setting of mango.

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## ILLUSTRATION

FIGURE 1. A typical perfect floret of Carabao mango.

2. A typical male floret of Carabao mango.

# FARMERS' CIRCULAR SECTION

# THE FLAX AS A SOURCE OF THREAD FOR LINEN AND SEED FOR LINSEED OIL

[Farmer's Circular 22]

By TIBURCIO G. GARRIDO
*Of the Bureau of Plant Industry*

THREE PLATES

In considering the cultivation of flax in the Philippines, one could hardly expect that the Islands would be a large producer of the product. There is, however, a good reason to believe that it could be grown here as one of our stable minor crops.

The average value of linen cloths and linen fabrics imported into the Philippines for four years beginning 1930 up to 1934 inclusive was ₱605,040.40 and that of linseed oil during the same period was ₱189,434.60 or a total of ₱794,475.00. This amount does not include the value of imported linen fiber mixed with other vegetable fiber. Our imports of flax-fiber goods alone indicate that we have been contributing a good sum every year to the flax industry of other countries.

This circular presents the cultural methods of the common annual flax, including the methods involved in the manufacture of crude fiber and its uses. The uses of the flax seed is also included here.

## TYPES OF ANNUAL FLAX

Two distinct types of annual flax, *Linum usitatissimum*, are now recognized by flax growers: the seed-flax and the fiber-flax. The seed type has short stems and many branches, and is cultivated for seed only (Plate 2, Fig. 1) for linseed oil; whereas the fiber form has fine, long slender stems, few branches and is grown primarily for fiber used for linen (Plate 2, Fig. 2). The seed raised from the fiber type, although produced in relatively less quantity, may also be used for the manufacture of linseed oil.

## CLIMATIC RELATIONS AND SOILS

Flax grows successfully in a wide range of latitude, from the tenth to the sixty-fifth north latitude and in a similar range

of southern latitude. The Philippines is located between the fifth and the twentieth north latitude indicating a high probability that the raising of this crop in the Islands is possible.

This plant, especially the fiber flax, requires, during the growing season, a moderate, cool and damp weather, that is, a humid atmosphere and a moderate temperature. Such conditions are found in many places in the Philippines during November, December and January. Accordingly, too much rainfall is inimical to the normal development of the plants while hot and dry weather stunt its growth, thus producing not only small quantity but also poor quality of the fiber. The flax is, therefore, exacting with regard to soil moisture.

The kind of soils for flax is not quite so important as flax may grow well from loam to clayey soils which are practically the types of soils we have. It needs, however, a rather compact or heavier subsoil with greate capacity to retain moisture. It has been found that the heavier types of soil out-yield the lighter soils consistently. Flax is a shallow feeder and it is not hard upon soils for it takes less plant food from the soil than many of the other crops.

## CROP ROTATION FOR FLAX

Flax requires a well-planned crop rotation. With flax, a crop rotation is not only intended to improve the soil both as to the chemical and physical properties, but also to control the weeds as well as diseases which prove to be very pernicious to flax crop. In this connection, we should follow the practice of other flax-growing countries, that is, they adopt different periods of rotation from five to ten intervening years between two crops of flax. In the Philippines, flax should follow any clean-cultivated crop that will leave the soil clean and free from weeds. A heavy good crop of upland rice or a well-cleaned or cultivated corn crop and other legumes that leave the soil clean may precede the flax crop.

## PREPARATION OF LAND

The land intended for flax planting should be well pulverized and evenly surfaced, free from stubbles, rubbishes and clods. Even or smooth surface of the seed-bed is necessary to have uniform growth of the plants. The subsoil should be made firm and compact before sowing the seeds. This condition can be obtained by passing a heavy wooden roller over the seed-bed one or two times.

### PLANTING AND SEEDING

In the Philippines, flax should be planted at the end of the rainy season or during the cool months of the year when there are only some light rain or shower. In many places in the Philippines, November or early in December is the most appropriate time to plant flax, for then the weather is usually moderately cool and damp.

After the seed-bed has been prepared in the manner stated above, the seed is broadcasted by hand and then harrowed into the soil. In harrowing, the native wooden tooth harrow or the bamboo tooth harrow may be used. The seeds should be evenly distributed and should be buried from ½ to 1 inch deep into the soil. Uniform depth of planting is essential for uniform growth of plants which gives good quality and uniform length of the fiber.

After harrowing in the seeds, the wooden roller is passed once or twice again to make the soil surface firm and packed. This is necessary to produce a good stand of the plants because many of the seedlings coming from seeds placed in loose soil will not be able to live or thrive well.

The flax seeds should be planted just thick enough to produce tall, fine and slender straw which yields long, fine, silky and soft fiber (Plate 2, fig. 2). Thick planting prevents profuse branching which lowers both the quantity and quality of the fiber. For fiber production a hectare requires from 70 to 100 kilos of seeds and for seed production from 30 to 40 kilos of seeds. The amount of seeds to be sown depends upon the quality and percentage of germination of the seed. In both cases the seeds for planting should be carefully graded and selected. Only sound plump seeds should be planted.

### HARVESTING AND CARE OF SEEDS

The crop can be harvested for fiber in 80 to 90 days and for seeds, in 100 days or more, depending upon the prevailing weather. In warmer days, it takes shorter period.

There are three stages at which flax can be harvested: (*a*) the green ripe; (*b*) the yellow ripe; and (*c*) the full ripe. In the first stage, the plants have attained full bloom but the stems and leaves are yet green. With great care, a very fine fiber can be extracted at this stage. The second stage is the time when the lower one-third of the stems are yellowing, the leaves are beginning to drop off, and some 30 to 50 per cent of the seed

bolls are ripe, yellow to brown in color, yielding about 70 per cent well-developed brownish seeds (Plate 2, fig. 2). These seeds may be used for propagation and for oil production. At this stage, the fiber produced is silky and of medium fine but much stronger than those from the first stage. Most flax for fiber is harvested at this stage. The third or last stage refers to the condition of the plants when all the leaves have dropped off and all the seed bolls matured or the plants are dead. At this stage the stem becomes too woody or hard and the fiber is lignified, losing its silkiness, luster, elasticity and strength, but the amount of seed yield is the greatest. The seed flax is always harvested at this stage.

Pulling by hand is the most common method of harvesting fiber flax. There are three good reasons for this: (*a*) it avoids staining and damaging the fiber; (*b*) it gives better curing of the straw and ripening of the seeds; and (*c*) it produces straw of long fiber.

After curing the straw, the calyx and the seed bolls become brittle, hence, the seeds are easily extracted without injury to both the stem and branches. The seed bolls are crushed into pieces; then by winnowing the seeds may be separated from the chaffs which are blown away together with the lighter, immature and poorly developed seeds. All the plump, sound and normal seeds should be kept dry in cloth or paper bags, placed in wooden box or cigar box which is then stored in cool, dry and dark place or, if possible, kept in seed cabinet or larger boxes.

The flax seeds, like most oily seeds soon lose their vitality when subjected to the warm and moist atmosphere. To prevent loss of germination, they should be kept dry and stored in dry cool place as stated above.

## RETTING AND MANUFACTURE OF FIBER

After the stalks have been uniformly dried and cured, they are retted for fiber extraction. Retting is the process by which the fiber is loosened from the woody portion of the stalks. During the process the gummy substances together with the weaker tissues which bind the fiber are dissolved.

There are three methods of retting flax straw; namely, the chemical method, the water retting, and the dew retting. Up to the present time, there is no successful retting by means of chemicals; they proved either expensive or destructive to the

flax fiber. Water retting has been used to a certain extent in some places in Belgium, Russia, and the United States. The straw in bundles are placed for some time in water in the tanks, reservoirs, or in flowing rivers or streams until the fibers may be easily separated. This method is rather delicate, needing a very close supervision by experienced hands.

The dew retting is the most extensively used by the fiber-flax growing countries. This process is the most practical method to use here in the Philippines. The threshed straw is evenly spread in thin layers in straight rows on a moist grassy meadow. An evenly growing grass should be preferred to insure uniform retting. The bacterial action facilitated by the presence of moisture from the dew and rain tends to dissolve the gummy substances and the weaker tissues which bind together and keep the fiber tissue to cling to the woody portion of the stalks.

The flax straw is completely retted in 15 to 20 days during the drier months and in 10 to 15 days during the rainy days. Usually the straw is turned over only once during the process. As soon as the cuticle can be separated mechanically and the separation of the fiber bundles from the rest of the cortex becomes easy, the retting may be considered complete.

*Breaking, scutching, and hackling.*—Thoroughly dried well-retted straw looks bright with a peculiar sweet odor (Plate 3, Fig. 1). The wood and the outer skin become harsh and brittle while the fiber is more or less elastic and tough. The straw in small convenient size bundles is pounded with wooden mallets, breaking the wood to short small pieces called shives (Plate 3, Fig. 1). These shives are all removed by combing or scutching. The scutched fiber is still reduced to finer divisions by hackling process (Plate 3, Fig. 2). Breaking, scutching and hackling are done by machinery in the United States and other countries, although it is admitted that the best work is done by hand. With a well-graded hackling, the fiber may be divided into the desired fineness for the spinner.

## FLAX PRODUCTS

The fiber is used for the manufacture of high-grade linen cloths for garments, napkins, table runners, towels, handkerchiefs and strong sailcloths; twine for the manufacture of rope and cordage and strong sewing threads for shoe manufacture and fine embroideries. Strong grade linen cloth was made into wings for aeroplanes during the World War. From linen,

a pulp is obtained which is made into paper of varying qualities from thick ones to a very thin kind used for the manufacture of wrappers for costly cigarettes.

The seed of this plant produces valuable oil, the linseed oil, used in making linoleum and oil cloth, for medicinal purposes, and as ingredient of paint and varnishes.

## COST OF PRODUCTION AND CASH RETURN

For obvious reasons, the cost of production and cash return should be included in this circular. In the following two tables the figures represent conservative estimates of the cost of raising and manufacturing crude fiber and cash returns from one hectare of fiber flax. Table 1 shows the itemized expenses of the farmer and the possible cash returns from the straw, if his business is to raise only the straw for the manufacturer. From these estimates, the farmer can realize a net income of ₱52 aside from the possible labor income of not less than ₱48 per hectare.

If the farmer manufactures the crude fiber his labor income will be increased from ₱48 to ₱104 and his net income to ₱127.30 per hectare.

On the other hand, as shown in Table 2, the manufacturer of crude fiber can get from three tons of straw a net income of ₱75 besides the labor income of ₱56.

## ACTUAL AND ESTIMATED YIELD FROM THREE STATIONS

Table 3 shows the days of maturity, the actual and estimated yield of the two varieties of both straw and seed per hectare as tried in plot tests in three stations in the Philippines. These data were obtained from the second year of their introduction here. It is to be noted that per average the Riga grows taller by 4.2 cm., produces straw 0.53 of a ton more per hectare and gives 0.89 of a kilo more of crude fiber per hectare (see "Flax in the Philippines." The Phil. Jour. of Agric. Vol. 7. No. 2, p. 231, 1936), than the Dutch. The latter, however, produces 16.66 kilos of seeds more per hectare than the former. The range of maturity is not very significant because both of them mature almost at the same time. The results indicate that Riga outyielded the Dutch in all the stations where trials were made. In this connection, it seems that Riga is more productive for fiber productions than the Dutch so that if we are concentrating our effort to produce straw for fiber, then this variety is more profitable to grow than the Dutch.

TABLE 1.—*Farmer's expenses and cash returns per hectare*

| | |
|---|---|
| Preparation of land (cleaning, plowing, harrowing, rolling and leveling) | ₱30.00 |
| Seeds, 80 kilos, at ₱0.25 per kilo | 20.00 |
| Planting (broadcasting, harrowing in and rolling) | 4.00 |
| Harvesting, stocking, and curing | 14.00 |
| Total expenses | ₱68.00 |
| Gross returns: Yield per hectare, 3 tons of straw, at ₱40 per ton | 120.00 |
| Total expenses | 68.00 |
| Expected net income | ₱52.00 |

TABLE 2.—*Manufacturer's expenses and cash returns per hectare*

| | |
|---|---|
| Three tons of straw, at ₱40 per ton | ₱120.00 |
| Retting, spreading, and bunding | 6.00 |
| Breaking, scutching, hackling and bailing | 40.00 |
| Miscellaneous other expenses | 10.00 |
| Total expenses | ₱176.00 |
| Long fiber, 6.82 piculs, at ₱34 per picul | 232.00 |
| Two or short fiber, 2.27 piculs, at ₱8.50 per picul | 19.30 |
| Gross returns | 251.30 |
| Total expenses | 176.00 |
| Expected net income | ₱75.30 |

## SUMMARY AND SUGGESTIONS

1. Fiber flax is a short-season crop harvested in 80 to 90 days from the date of planting.

2. It needs moderate, cool and damp or humid atmosphere. Too much rain is destructive to the plants. Slight rain or shower favors the vegetative growth of the plants.

3. Flax requires a well-planned rotation of crops in order to control weeds, pests and diseases. The flax crop should follow pasture, meadow or clean-cultivated crops.

4. Flax requires a firm and packed seedbed. This helps germination and maturity.

5. Only clean, plump and well-matured seeds should be planted. A portion of the field should be set aside for seed production, for propagation or the fully developed brownish seeds which are produced at harvesting the crop for fiber could also be used for propagation purposes. Any weed growth should be removed to avoid admixture of weed seeds, and the seeds should be cleaned and thoroughly graded.

TABLE 3.—*Showing the days of maturity, actual and estimated yield of straw and seed of the two varieties of flax grown in the Central Station (Manila), Economic Garden (Los Baños, Laguna), and Tanauan Station (Batangas), in 1935–36.*

| Station | Variety | Days of maturity 50 per cent matured bolls | Actual area planted | Straw | | | Seed | |
|---|---|---|---|---|---|---|---|---|
| | | | | Average length at harvesting time | Actual yield | Estimated yield per hectare | Actual yield | Estimated yield per hectare |
| | | | *Sq. M.* | *Cm.* | *Kilos* | *M. T.* | *Kilos* | *Kilos* |
| Central Station, Manila | Riga | 79.00 | 35.00 | 81.03 | 11.90 | 3.40 | .95 | 270.00 |
| Economic Garden, Laguna | Riga | 90.00 | 200.00 | 76.20 | 56.80 | 2.84 | 5.60 | 280.00 |
| Tanauan Station, Batangas | Riga | 88.00 | 50.00 | 64.32 | 14.30 | 2.86 | 1.60 | 320.00 |
| Average | | 85.66 | | 73.85 | 27.66 | 3.03 | 2.716 | 290.00 |
| Central Station, Manila | Dutch | 85.00 | 35.00 | 76.10 | 10.35 | 2.96 | .98 | 280.00 |
| Economic Garden, Laguna | Dutch | 91.00 | 25.00 | 71.80 | 5.03 | 2.01 | .75 | 300.00 |
| Tanauan Station, Batangas | Dutch | 88.00 | 50.00 | 61.05 | 12.60 | 2.52 | 1.70 | 340.00 |
| Average | Dutch | 88.00 | | 69.65 | 9.33 | 2.50 | 1.14 | 306.66 |
| Do. | Riga | 85.66 | | 73.85 | | 3.03 | | 290.00 |
| Difference | | 2.34 | | —4.20 | | —.53 | | 16.66 |

6. Seeds should be set from ½ to 1 inch as deeper seeding may not grow up.

7. The preliminary tests made in our stations in the Philippines show an average yield for two varieties tested, the Riga and Dutch, 6.82 piculs of scutched fiber and 2.27 piculs of tow or short fiber per hectare. This yield compares favorably with the average yield of other flax-growing countries. (Reference can be made in published article, "Flax in the Philippines," The Philippine Journal of Agriculture, Vol. 7, No. 2, pp. 229–241, 1936.)

8. According to a conservative estimate of the cost of production and cash return from one hectare of flax fiber, a net profit of ₱52 for the farmer and ₱75.30 for the manufacturer may be realized.

9. Flax would make a good minor cash crop in the Philippines, but if the cultivation of this crop is extended here, we should follow the examples of other flax-growing countries, like the Soviet Russia, Belgium, Netherlands, Latvia, United Kingdom and other flax-producing countries, where the producers, small farmers, grow the flax and sell the straw to the factory where the straw is retted and the crude fiber is manufactured.

## ILLUSTRATIONS

### PLATE 1

Fig. 1. Riga flax fiber acclimatization and selection tests at the Central Experiment Station, Bureau of Plant Industry, Manila.

2. Dutch flax fiber acclimatization and selection tests at the Central Experiment Station, Bureau of Plant Industry, Manila.

### PLATE 2

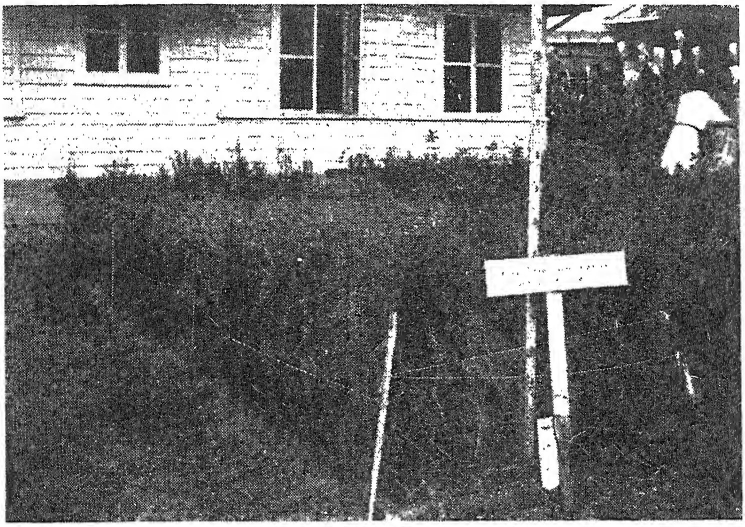
FIG. 1. The flax plants (north Dakota 187), showing the characteristic of the seed type.

2. The straw of the Riga and the Dutch varieties showing their relative length, and their fine and slender straw of the fiber type. This straw when retted properly yields long, fine, silky and soft fiber.

### PLATE 3

FIG. 1. The Riga flax fiber variety showing the retted straw, right, the fiber after breaking and hackling the straw, left, and the scutched fiber, center.

2. The scutched or combed fiber produced from the retted straw of the Riga and the Dutch varieties.



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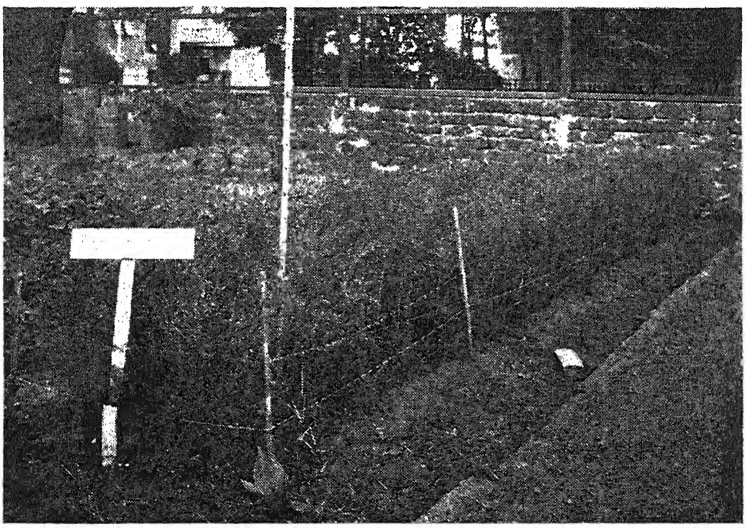

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PLATE 1.

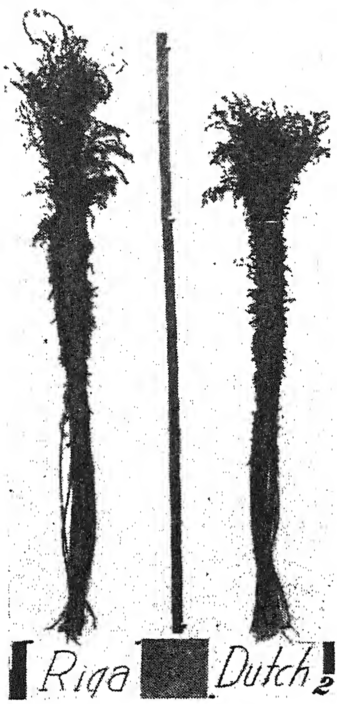
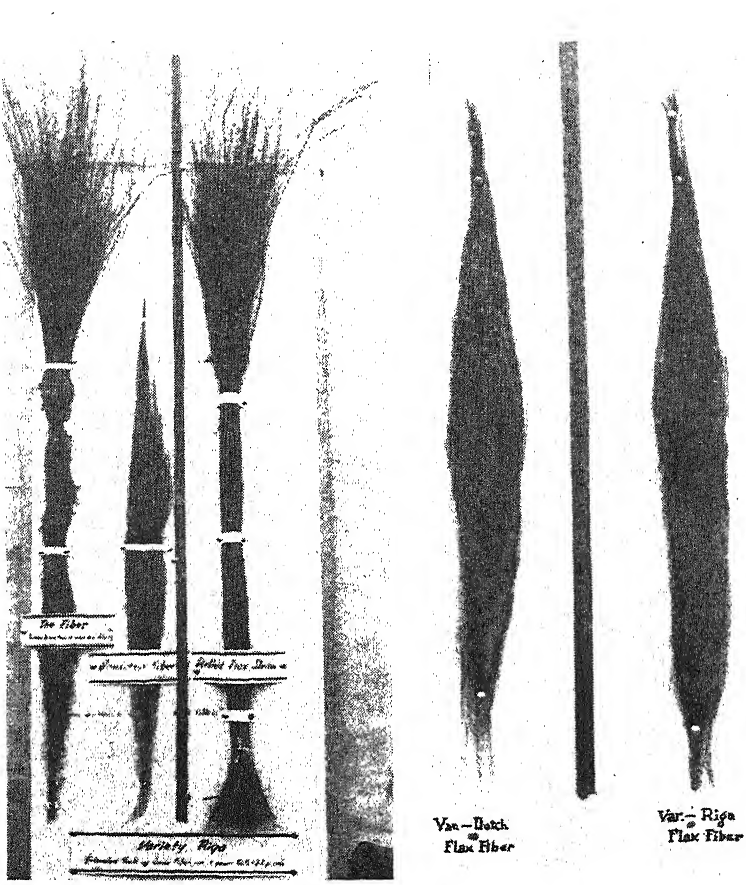




PLATE 2.


The Fiber
Variety Riga
Van—Dutch Flax Fiber
Var.—Riga Flax Fiber

1 2

PLATE 3.

# CULTURE OF EDIBLE MUSHROOMS IN THE PHILIPPINES

[Farmers' Circular 28]

By FELICIANO M. CLARA

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*Bureau of Plant Industry*

FIVE PLATES

Mushroom is not so readily raised as ordinary vegetables. The peculiarity in the requirements for its growth and the execution of the methods of culture, varying according to people, conditions and the locality, may sometimes cause failures. More so in the Philippines where no previous systematic study on mushroom culture has ever been made. The only scanty information and attempts at cultivation are based upon the appearance of this vegetable as it occurs in nature during certain season of the year. The demand for this much desired delicacy is supplied by canned and dried mushrooms imported from foreign countries.

A great deal of the success in mushroom growing is dependent upon five main requirements: (1) good spawn, (2) suitable materials or substrata for beds, (3) proper construction of beds and spawning, (4) proper supply of moisture in watering the beds, and (5) control of diseases and pests attacking mushrooms.

The method of cultivating mushrooms contained in this circular is based upon the results of the investigations conducted by the Bureau of Plant Industry.

## THE SPAWN

Mushroom spawn is the material with which the plant is propagated. There are two kinds of spawn—pure culture spawn and wild spawn or "virgin spawn." The former is a prepared pure culture of the fungus in a suitable medium, while the latter is a material from the field or a bed which contains mycelium and spores of the desired mushrooms such as, for instance, rice straw on which edible mushrooms may be found growing. Where pure culture spawn is not available the "virgin spawn"

may be used. In countries where mushroom growing has reached a very high degree of development, the pure culture spawn is used (Plate 2). Its preparation is a business by itself conducted by mushroom spawn dealers. It requires laboratory methods and equipment.

In the Philippines there are no mushroom spawn dealers. There are some imported spawns from foreign countries, but they are not suitable to Philippine climate. Unless they are planted in air-conditioned mushroom houses with regulated temperature and moisture, or in regions with semi-temperate climate like Baguio, they are not expected to grow. Caves such as those in the abandoned mining districts may also be found suitable for this type of mushrooms. There is a kind of spawn imported from China which is not pure culture and its true worth under Philippine conditions is not yet known. This spawn is the rice straw of which the beds are made. After the mushroom is harvested, it is gathered and used for spawning new beds. Spawn of Philippine edible mushrooms may be obtained in a similar manner and used for planting new beds especially when no sufficient pure culture spawn is obtainable.

In the method described in this circular, both pure culture and wild spawns of the Philippine edible mushroom of the type *Volvaria esculenta* are used. The pure culture spawn is more advantageous than the wild spawn which appears to be uncertain as to its productivity.

A limited quantity of pure culture spawn of Philippine edible mushroom is prepared by the Bureau of Plant Industry (Plate 2). Some of these have already been distributed for coöperative trial plantings. The number of people interested in mushroom growing is increasing and so is the demand for spawn which sooner or later will bring about a new industry for spawn dealers.

## THE BEDS

*Location.*—The beds should be located near a good source of water supply. Flat lands and rice paddies after dry season harvests may be found convenient for this purpose. Lands protected from strong winds such as those with natural wind breaks, hill sides, near bamboo trees or any planting that protect the beds from strong winds, offer suitable locations since moist condition may be more readily obtained with such protection than in the open fields. During the months of June, July, August, September and October open fields may be found suitable for during these months the conditions are suitably humid

for mushroom growth. Prolonged heavy rains are as injurious to mushroom growth as the dryness that follows the rainy season.

*Materials for beds.*—There should be a good supply of dry rice straw to be used in making beds. Abacá fiber refuse, banana stalks, tobacco midribs, old gunny sacks, and abacá mat trimmings (Plate 3) are useful as layers for spawning and as mixtures with rice straw in making the beds. The rice stalks usually left in the paddies after harvesting are suitable materials and may be superior to the ordinary straw with the leaves. Where tobacco midrib is procurable it may be mixed with straw about 2 to 7 or 3 to 7 by parts. All of these materials should be well dried before using them for making beds. The rice straw composed of the stalks should be used as the main part of the beds and the finer ones with the leaves as covers or final layers.

*Construction of beds and spawning.*—The beds may be constructed with any desired length. The height is about one meter or slightly less from the level of the ground and about 90 centimeters wide. The first step is to make a bed of garden soil preferably clay loam, about 25 centimeters from the ground level. The soil should be pressed well and leveled on the surface. This foundation of the bed can be well packed by moistening the soil during construction. The surface of the bed is sometimes fashioned like a trough by making a dike 15 centimeters wide, and 5 centimeters thick all along the edges. In places where no pipe system for water supply is available a canal 30 centimeters wide and 10 centimeters deep and from 32 to 40 centimeters away from the bed should be made for every two beds.

As soon as the soil foundation is ready, spawning should be done. Before planting the spawn, a thin layer of any of these materials—abacá fiber refuse, dry banana leaf sheats, old abacá sacks or mats, gunny sacks, that are usually thrown away—should be used as first layers on the top of the soil part of the bed. These materials should be wet by soaking or sprinkling before placing them on the bed. This method gives a very favorable growth for the fungus. The spawn is planted on this layer along the edges 5 to 8 centimeters from the sides and 15 to 30 centimeters apart. In planting, the spawn (Plate 2) is taken out of the bottle by picking it with forceps or any convenient tool or by breaking the bottle. Care should be taken not to tear the spawn into very small lumps or pieces. It is then divided into pieces about 5 or 6 cubic centimeters a piece.

The pieces of spawn may be planted on the beds as pieced out of the mass. If a good supply of spawn is available it is better to use bigger pieces and make the distance closer. In case of wild spawn, it is planted by spreading it evenly on the bed.

After planting the spawn, wet straw is laid and pressed evenly on the bed. When the layer of straw is about 15 centimeters thick another spawning may be done in the same manner as in the first layer. Wet straw is gain piled up and pressed well by stepping on it until the bed is about a meter high. It is necessary that the straw is well packed. An idea of laying the straw and the final shape of the bed may be gained from (Plates 4 and 5).

*Watering and care of bed.*—During summer, which is not a season for mushroom, it is possible to raise this vegetable by providing the beds with the right amount of moisture. After planting the spawn the beds should not be watered for one week. Watering may be done two or three times a week thereafter. The soil should be kept moist by allowing some of the water from the top of the bed to drip slightly or sip down on the sides. The canals are occasionally flooded when the surrounding is very dry. Excessive or standing water will destroy or prevent the growth of mushrooms. Good judgment gained from experience determines the amount of water needed and the time it is needed. In the rainy season, particularly during the most favorable weather for mushroom growth (June, July, August, September and October), watering may not be necessary at all. Watering during the dry season should be done regularly and carefully until the mushrooms appear in the "button" stage. The soil should be kept moist by judicious watering. As soon as the "buttons" are noticed, watering should be slight because plenty of water destroys the young mushrooms and favors the development of diseases. Spraying with fine showers is sufficient when the beds are bearing. If a sprayer is not available, sprinkling to allow moistening of the sides is sufficient. If it is desired to grow mushrooms all the year round, the beds should be under some kind of roof to prevent too much water during rainy season as well as too rapid drying during summer. Galvanized sheet iron may be used as covers instead of a roof.

*Harvesting.*—Seventeen to 20 days from the date of spawning, a good crop of mushrooms may be ready for harvesting. Sometimes the first flush appears in 11 days. They should be harvested while young (Plate 3). In harvesting, care should be taken not to injure or disturb the mycelium and the neigh-

boring "buttons". At times there are several plants in a clump with several "buttons" adhering or growing adjacent to the base of the clumps. The plants to be harvested should be separated or picked up carefully with the aid of a knife. The plants should be twisted after having a firm hold of the base with the thumb and fingers. In this manner the base or stump is pulled out with the mushrooms. If stumps or bases are left on the beds they decay and serve as a source of infection and infestation.

*Diseases and pests.*—Mushrooms are subject to a number of destructive diseases and pests. Practically nothing is previously known about mushroom diseases and pests in the Philippines. This is of course to be attributed to the absence of the industry and studies along this line. In the mushroom projects of this Bureau, diseases and pests appeared just as soon as the work was in progress. The disease known in other countries as bubbles caused by *Mycogone perniciosa* is very destructive. The "plaster mold" or "flour mold," *Monilla fimicola* and another fungus very similar to truffles fungus, *Pseudobalsamia microspora* are also apparently encountered.

Among the pests mites, millipeds, grubs and earthworms are very common. They cause much destruction to the "buttons" and the growth of the mycelium. Mice and lizards are other pests to reckon with. The latter is particularly very voracious. It eats mushrooms in the "button" and matured stages.

The use of tobacco decoction for the control of the insects, soil sterilization for the fungi, and fencing the mushroom field with wire will greatly minimize and in some cases may completely check damages caused by these enemies. Derris powder or decoction may also be found useful in the control of the pests. Saturated solution of lime used in the soil of the beds before planting greatly minimizes the damage caused by earthworms.

# ILLUSTRATIONS

PLATE 1.

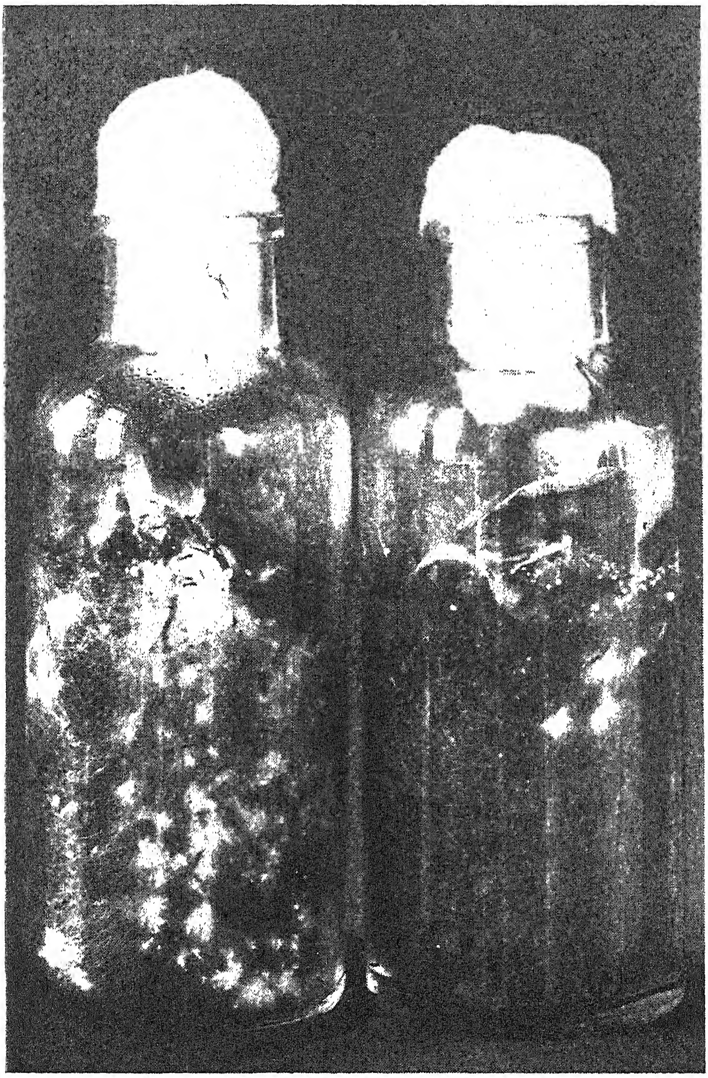

PLATE 2.

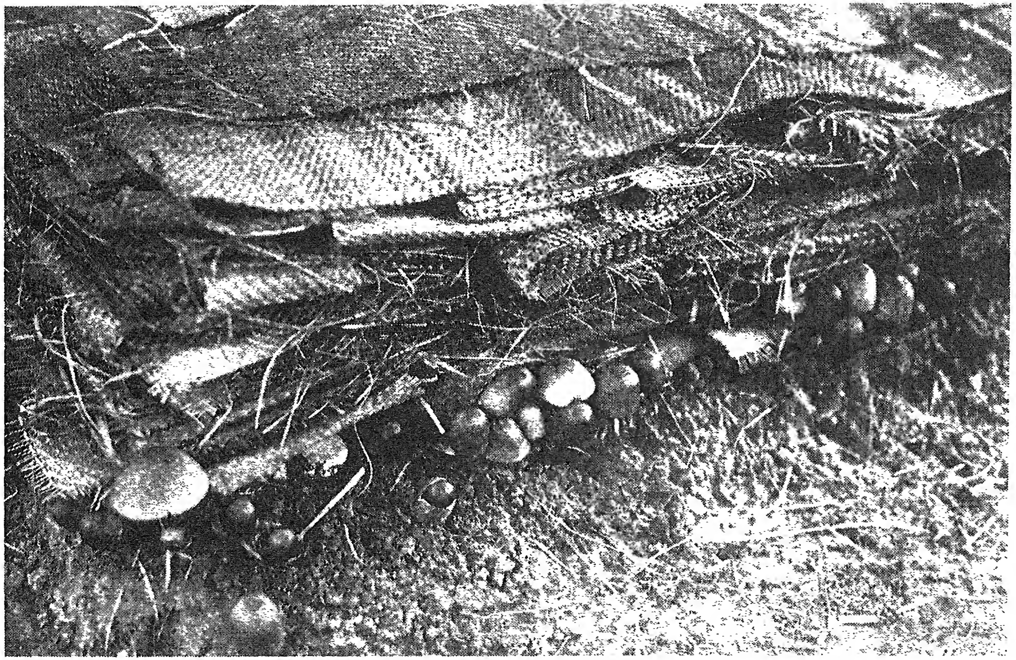

PLATE 3.

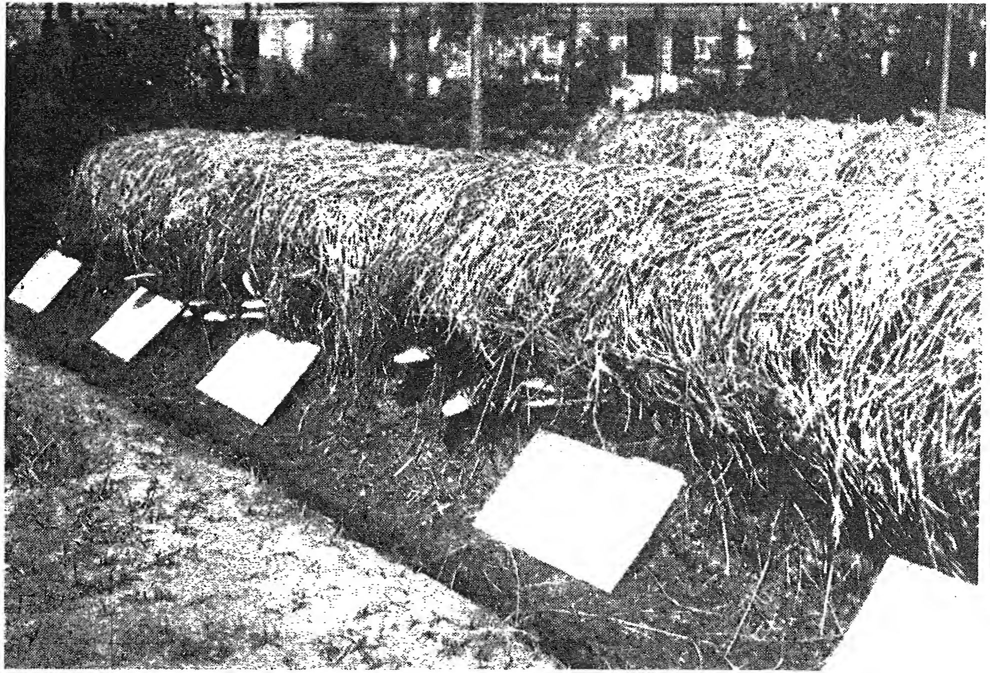

PLATE 4.

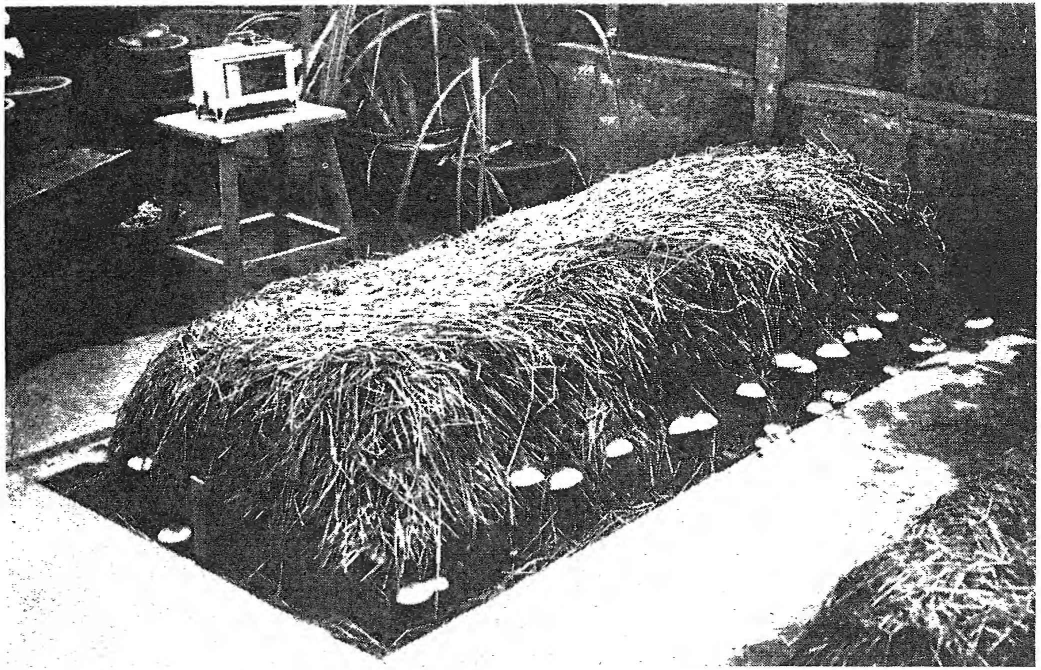

PLATE 5.

# THE PROPAGATION OF PLANTS

[Farmers' Circular No. 40]

By SIXTO L. SISON and EPITACIO A. LANUZA

*Assistant Agronomists*

SEVEN PLATES

Plants may be propagated in two ways: (1) sexually or by seeds and spores, and (2) asexually or vegetatively.

By sexual propagation is meant the reproduction of plants by means of seeds and spores; e. g., the propagation of cereals as palay and corn; fruit trees as mango, caimito, etc.; legumes like mongo and cowpeas; ornamental plants like coreopsis and zinnia. Ferns, both edible and nonedible ones, are by nature propagated by spores.

Asexual or vegetative propagation is the reproduction or perpetuation of plants through the use of a growing or vegetative part either naturally, such as by means of suckers, bulbills, tubers, rootstocks, sets, stolons, corms or cormels, etc.; or artificially, like for instance by means of cuttings, layering, inarching, marcotting, budding, and grafting.

Since vegetative propagation or asexual reproduction is one which is least understood but one which is very important especially in orcharding, this paper will deal mostly on this method. At the outset, mention could be made of the advantages on this method of propagation which are as follows:

1. It is the most practical and surest means of perpetuating the desirable characters of parent plants. In the case of reproduction by seeds, the resulting plants in most cases do not come true to type or do not have the same desirable characters as the parent plants.

2. In the case of budded or grafted plants the stock best adapted to the soil and climate of a given place, congenial for the scion and most resistant to certain pests and diseases, can be used; thus a fruit grafted upon the proper stock can be cultivated in a region where cultivation on its own roots would be hardly possible, if not altogether impossible. Good stocks impart a certain degree of vigor and productivity to resultant

trees. The establishment of the grape industry in the New England States of the United States has been attributed to this method of plant propagation. When rooted cuttings of grapes, producing a heavy yield of luscious fruits, much in demand in the New England States, were first imported from Southern France, the venture was a total failure; because the roots were attacked by a certain root disease prevalent in that region. However, by grafting scions of the imported varieties to native stock resistant to the said root disease, the industry was successfully established.

3. Vegetatively propagated plants bear fruits earlier and therefore yield profits earlier. Many seedling trees are not only poor producers but also sterile.

4. Orchards grown vegetatively are made more uniform both in growth and in the quality of fruits; the latter being an important consideration in marketing.

5. Because of the nature of growth of vegetatively propagated plants, pests and diseases are easy to control, too much wind injury obviated, and gathering of fruits made easier.

There is only one alleged disadvantage of vegetatively propagated plants and that is they do not grow as big or as fast as seedling plants. This assertion, however, is not wholly true as grafted carabao mango plants in northern Occidental Negros and eastern Batangas grow bigger and faster than seedling trees of the same age but they seldom bear fruits or not at all. The probable reason why grafted trees do not grow as fast as seedling trees is because grafted trees bear fruits earlier. It is a well-known fact that the production and maturing of a fruit, especially in the case of heavy producing carabao mangoes and Batangas mandarins, is such a very exhaustive process that after one season of very heavy fruiting, hardly any food supply is left even for growth purposes so that the growth of a tree is delayed even as much as one whole year. Thus, while early producing grafted mangoes for example grow once only every two years seedling mangoes are undisturbed in their growth habits and hence after a period of time are even twice as big as grafted trees.

## PROPAGATION BY CUTTINGS

Cuttings may be divided into: (1) root cuttings, made from roots as in the case of the rimas; (2) stem cuttings, made either (*a*) from the tender immature parts of plants and called soft-

wood cuttings as of gummamela, San Francisco, etc., or (*b*) made from the mature growth and called hardwood cutting as in the case of certain ornamental plants like Bougainvilla, Campanilla, etc., (3) leaf cuttings made from the leaves, as in the case of the Begonia plant.

All of the above cuttings may be rooted in peat moss, which may be obtained from nurserymen and seed dealers. In its absence, however, clean, medium coarse sand or sandy loam soil could be used for root, softwood, and leaf cuttings. For hardwood cuttings, ordinary loam soil which crumbles easily should be used. In all cases, never use manure so as to prevent infection of the cut portions. A bed or frame containing the above media may be used. In the case of root and hardwood cuttings, the bed or frame should be filled 20 centimeters deep with the required media and in the case of softwood and leaf cuttings, about 6 centimeters deep.

Root cuttings to be used should be 1 to 4 centimeters in diameter and sawed off into lengths of 20 centimeters each and the ends cut smooth with a sharp knife. The topmost cut should be painted with white lead or coal tar. Hardwood cuttings to be used should be about 20 centimeters in length and for softwood cuttings around 6 centimeters long and taken from the tender, immature, terminal ends of the twigs. In both cases trim off about two-thirds of the leaves. The cuttings should be placed diagonally, leaving about one-fourth of each cutting projecting above the surface and the media packed well so as to leave as little air space as possible between the media and the cuttings. In the case of root cuttings the big end of each cutting should be placed topmost.

Begonia is a good example of plants propagated by leaf cuttings. In this case, a leaf is divided into 2 or 3 parts each containing big veins and then pinned on the media of either moss or sand.

Precaution must be taken that in no case, from the time the cuttings are severed from the parent plants to their final planting in the frame or seed bed, should the cuttings be bruised or allowed to dry and wilt.

When the cuttings have rooted well and grown to about 8 to 12 inches high (for such plants as begonia the criterion is the development of 3 or 4 leaves), they should then be transferred to the nursery for some time until sufficiently well established to be placed in the orchard or garden. Plants like begonia should directly be transferred in pots or in permanent places.

## PROPAGATION BY LAYERING AND MARCOTTAGE

Layering is the rooting of a twig or branch while still attached to the parent plant and is done by pegging to the ground a notched branch or twig until it has rooted and is able to maintain itself before finally cutting off such branch from the parent plant. Because of its inconveniences, there being but very few branches close enough to the ground which may be pegged without breaking, this method of propagation is seldom, if at all, practised at present. Instead, marcotting or air layering, that is, causing the branch to root while on top of the parent plant, is being commonly practised.

For marcotting, a good-sized, medium-matured branch is selected. A ring of bark one-half inch to three inches in length (depending upon the size of the branch) is cut off making sure that the cut does not extend farther than the cambium layer. Scrape off all remaining bark so that there will not be any possibility for the cut to heal over and produce a new bark. Allow the cut portion to remain exposed for a few days or a week so as to let the cuts callouse. Then using a sandy loam soil or soil that easily crumbles with a slight pressure of the hand but one that does not contain animal manure so as to prevent infection of the cut portion, cover the cut portion with about two or three inches of soil all around. This soil should be held in place with coconut husk, well pounded so that proper irrigation and aëration can go on. Gunny sacks or any other convenient material may also be used. Tie tigthly with any strong tying material to prevent falling off. When the branch has already well rooted (and the roots are already properly matured and hardened), the branch may be severed with a pruning saw and the severed portion painted with white lead or coal tar to prevent infection. Coir dust instead of soil may also be used in lieu of the soil.

To avoid much expense in watering marcotted branch, propagation should be made at the beginning of or during the rainy season.

## PROPAGATION BY GRAFTAGE

Grafting is the process of transferring a part of a plant, which is to be propagated or perpetuated (called the scion or bud) into another (called the stock) which is the plant on which the operation is to be performed, with the intention that the scion and the stock shall grow together. For our purposes this method shall include budding also.

It must be remembered that grafting is not an improvement in itself but the means by which an improvement is effected; so that in order to produce plants that are of superior or desirable qualities, the scions to be used should come from plants possessing the desirable qualities.

In order that the scion or bud and the stock may grow well together as one plant, there must be a close affinity between the two. In general, scions of a given species may be grafted or budded into another plant of the same species, as for example, buds of sweet oranges may be budded on sour orange stocks; scions of a given species into another in the same genus, as for example, pineapple orange on Batangas mandarin stock.

The season at which the operation is performed apparently exercises some influences on the facility with which the union takes place. Many practical nurserymen believe that the best time to perform this operation is just before the flowering or fruiting season of each particular fruit tree, as during that time, the twigs and branches have much stored food materials which can be utilized for growth purposes. In mangoes, for example, this assertion seems to hold true as more successes in grafting have been obtained about the middle of the dry season than at any other period of the year.

### 1. SHIELD BUDDING

*a.* Rules to follow:

(1) The budding knife to be used must be clean and sharp.

(2) The stocks must be in such condition that the bark separates readily from the wood, allowing the easy introduction of the bud, and should have at least a diameter of one centimeter or more but not over matured. A plant properly taken care of and of vigorous growth should have attained this size in about one year.

(3) Proper budwood: The selection of the budwood, with the exception of a few species, is perhaps the most difficult problem for the beginner. (The kind of budwood to use and the stock on which they should be budded or grafted for each species is mentioned at the end of this article for guidance.)

(4) The budwood should not be allowed to dry from exposure to the air and sun.

(5) In cutting the bud, be sure that there is no break or tear in the tissues.

(6) In some species, the similarity of the age and appearance of the scion and the stock at the point of insertion is of prime importance, like for example in the case of mango, cacao, and santol.

(7) The bud should be inserted immediately after it is cut and should be tied at once with a conveniently good tape which

may be made by cutting crosswise into strips of about 20 to 25 centimeters long a fine-meshed cotton cloth previously washed to remove starch and dried. Then roll evenly one or two strips rather fairly tight on a previously prepared rounded bamboo or any other clean stick of about 30 centimeters long. Immerse these cloths 10 to 20 minutes in the following melted mixture of:

| | |
|---|---|
| Beeswax | 1 kilogram |
| Red resin | 2 kilograms |
| Beef "suet" (sebo) | 150 grams |

taking care not to overheat. Then remove to cool off. This tape is then ready for use.

(8) No water or impurities should be allowed to enter the bud.

*b.* Operation:

An inverted T cut, 3 to 4 centimeters or more in length, is made, through the bark and as deep as the cambium layer, in the stock. The cut should be made as near the ground as possible or at least about 20 centimeters above the ground, for in this way the buds have the tendency to sprout more readily than when they are inserted higher up in the stock. This will also save much time later in removing water sprouts. To facilitate insertion of the bud, loosen up the bark just sufficiently to allow it (the bud) to easily slip into place. In most stocks the proper loosening is easily made with a slight upward twist or swerve of the knife blade in making the vertical or cross cut. Next, a bud is cut, not less than 2 centimeters long, taking care not to cut the bud too thin and that no break or tear is made in the tissues. In thick-barked and rapidly growing species, the buds should be cut large with an ample wood-shield as otherwise, they are in danger of being grown over by the callous after they have taken and before the bud growth has started. After this cutting the bud is inserted in the cut and tied firmly, but not very tightly as to strangle the bud, with grafting tape, beginning at the point of insertion and covering the whole bud so that no water can enter.

After about two weeks, if a good callous has formed around the bud shield, which often is the case, un-wrap the tape to expose the bud. If the bud is living, the tape must not be entirely removed as opening of the bark may cause rotting to occur. Then make a notch or a cut about one-third through the stock at a height of about 6 to 8 centimeters above the bud union and opposite the developing bud.

Make a weekly inspection, or so, deepening the notch on the stock each time so as to hasten the growth of the buds. When

the growth of the bud is already about 5 centimeters high, loop the stock at the place of notching. When a growth of about 30 to 50 centimeters of the bud is attained, cut off the stock smoothly and slantingly with a sharp knife just above the union and paint the cut with a good paint for the purpose. Experiences show that asphaltum linseed oil paint is the best for this purpose. White lead may also be used. In fact for general purposes white lead is good. Coal tar has a slight burning effect on the tree. Asphaltum-linseed oil is prepared by mixing linseed oil and asphalt. The mixture is boiled so that the consistency is that of a white lead paint. The formula is: Asphalt—1 kilogram; linseed oil—350 grams. All sprouts on the stock should be rubbed off as soon as they appear. The budded plants will be ready for the orchard when about a meter high or more.

2. *Cleft grafting.*—This is done by cutting off the stock at right angle at the point where it is desired to insert the scion. A wedge-shaped scion 7.5 to 12.5 centimeters long, carrying three or four buds is then made. The stock is split in the middle with a grafting knife just long enough to properly insert and fit the scions. In inserting the scions into the stock, the cambium layers of the stock and the scion should be placed in close contact. Tie with grafting tape to cover and protect the wounds well from rain, dew, and fungi. The scion and part of the stock are covered with wet moss or banana leaf sheaths to keep the scion from drying. Remove the moss or leaf sheaths when the scion begins to grow, usually after 3 weeks.

*Proper budwood and stock to use in budding and grafting for each of our important commercial fruit trees as given by P. J. Wester and Jose de Leon:*

*Avocado.*—Use tender to mature, but green, smooth-petioled budwood; cut the buds 3.5 to 4.5 centimeters long; age of stock at point of insertion of bud unimportant. But on avocado stock of the same species.

*Caimito.*—Use fairly mature to well-matured, brownish to grayish, non-petioled scions. Insert the scions in the stock at a point approximately of the same appearance as the scions. Graft on caimito stock of the same species.

*Citrus.*—Use fairly mature to well-matured, petioled, green and smooth, preferably spineless and round budwood. Cut the bud 2.5 to 4 centimeters long. Age of the stock at point of insertion of bud unimportant. Stocks to use:

Bud mandarin on Batangas mandarin and orange stock.
Bud oranges on Batangas mandarin and orange stock.

Bud pummelo on Batangas mandarin and orange stock.
Bud lime on Batangas mandarin and sour orange stock.
Bud grapefruits on Batangas mandarin and rough lemon stock.
Bud lemons on rough lemon stock.

*Lanzon.*—Use well-matured scions. Insert the scions in the stock 6 to 10 centimeters above the ground, when at that height it is 7 to 15 millimeters in diameter. Graft on lanzon stock.

*Mango.*—Use non-petioled, mature, smooth, green scions from the first, second or third flush. Insert the scions in the stock at a point approximately of the same age and appearance as the scion. Graft on mango stock of the same species.

*Santol.*—Use non-petioled, fairly mature turning brownish, grayish, and rough, rather slender scions. Insert scions in stock at a point of the same age and appearance as the scion.

Explanation of terms:

*Petioled budwood.*—Budwood cut at the time of budding with leaves still attached. The petioles are cut off close to the bud before using budwood.

*Non-petioled bud-wood.*—Budwood which, when taken, has no more leaves, or budwood whose leaves have been cut off or removed sometime in advance prior to and about two weeks before cutting of buds. This is done to induce the dropping of the leaves and the formation of a well-headed leaf-scion.

*Scion.*—is the bud or branch which is inserted into the stock. This eventually becomes the shoot of the tree.

*Stock.*—that portion of the plant to which scion is inserted. This becomes the root of the future trees.

*Spores.*—equivalent to seeds of higher plants like reproductive body of ferns, a primitive reproductive body.

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2. LEON, JOSE DE. 1932. Citrus growing in the Philippines. Bureau of Plant Industry.
3. WESTER, P. J. 1920. Plant Propagation and Fruit Culture in the Tropics. Bureau of Agriculture Bulletin No. 32.

# ILLUSTRATIONS

PLATE 1

Different kinds of scions; (*a*) non-petioled and (*b*) petioled. (2) Budding tape.

PLATE 2

Different stages in budding: (*a*) cutting a shield bud, (*b*) shield bud, (*c*) stock ready for insertion, (*d*) bud inserted, (*e*) budded and tied, (*f*) bud partially exposed after about two weeks. Note notching at point N. (*g*) lopping (point L) to induce growth of scion (*k*) budded plant. Note method of cutting off of the seedling top.

PLATE 3

Stages in cleft-grafting: (*a*) stock cut and split ready for insertion; (*b*) scion cut and wedge-shape ready for insertion; (*c*) scion inserted in stock; (*d*) cleft-grafted and tied.

PLATE 4

(*a*) Pruning knife; (*b*) Budding knife; (*c*) Grafting knife; (*d*) pruning shear.

PLATE 5

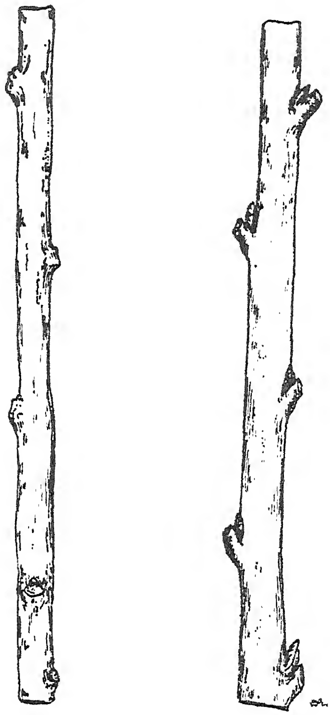
(*a*) Layering: Note pegging P.; (*b*) Inarching: B–*a* branch of mother plant, S—seedling.

PLATE 6

Marcotting: (*a*) marcotted branch, (*b*) portion of a branch with bark removed preparatory to wrapping, (*c*) marcotted and wrapped.

PLATE 7

Cuttings: (*a*) soft-wood cutting, (*b*) hard-wood cutting, (*c*) root cutting, (*d*) leaf cuttings. Note the method of cutting a leaf into three parts.



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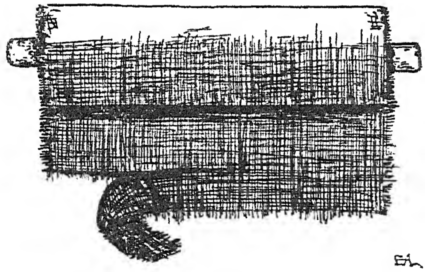

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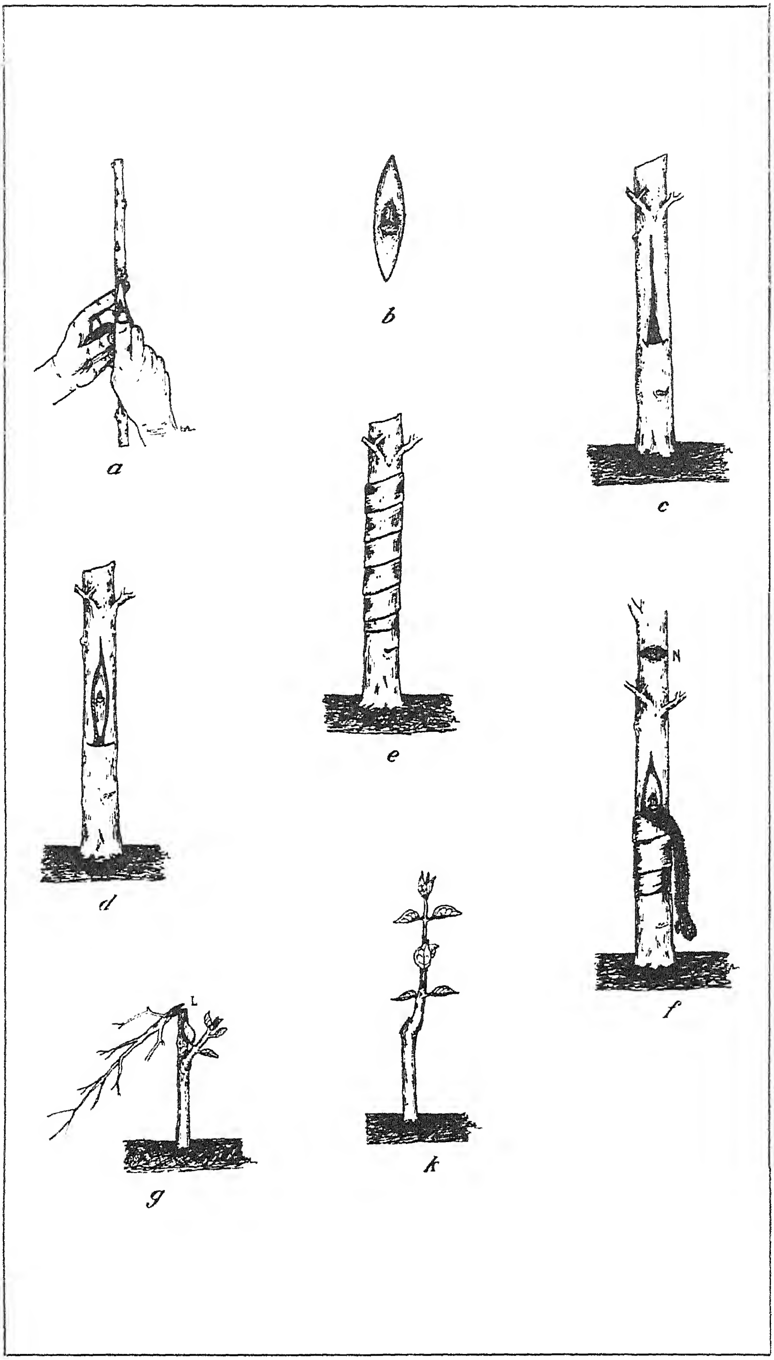
PLATE 1.



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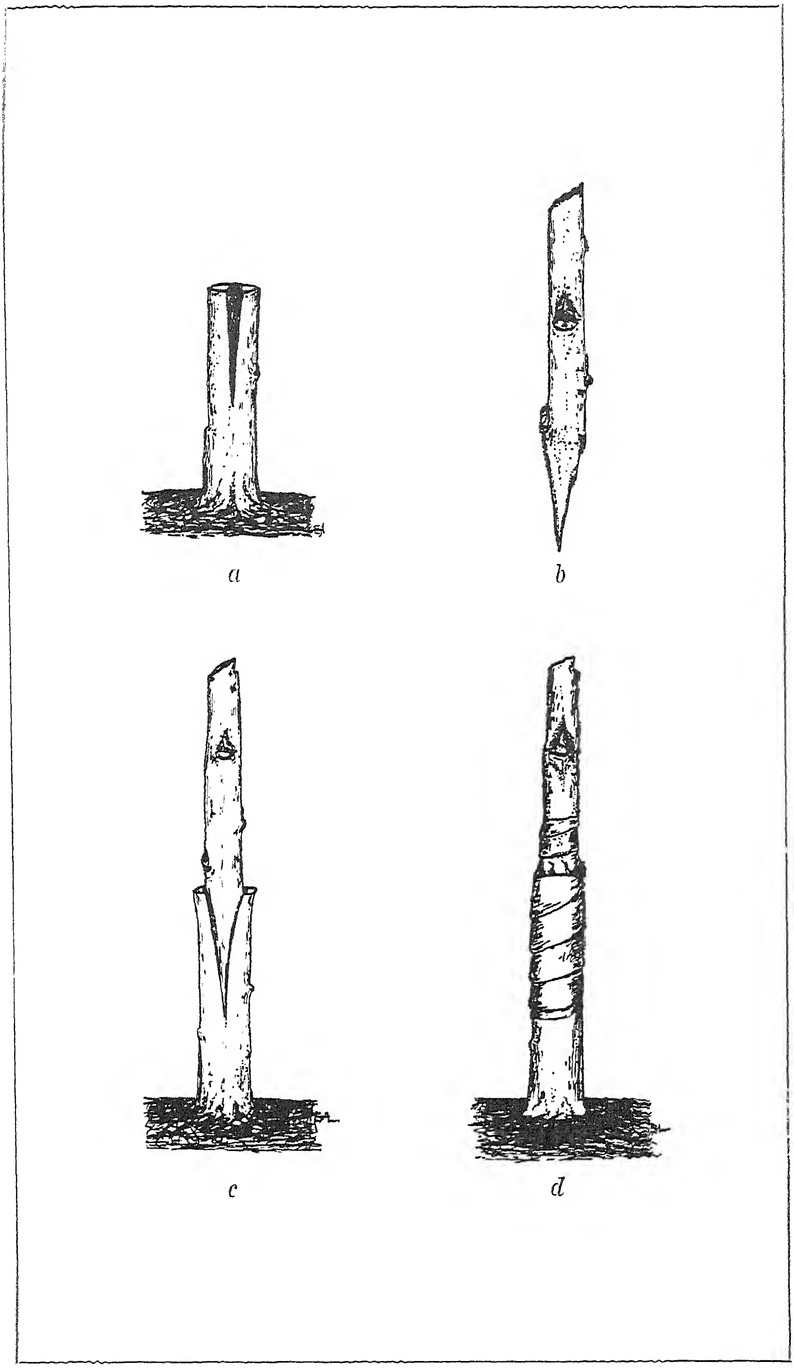
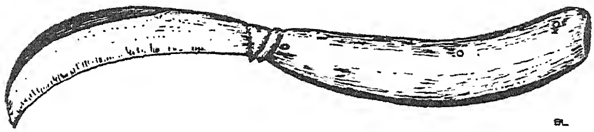



PLATE 3.



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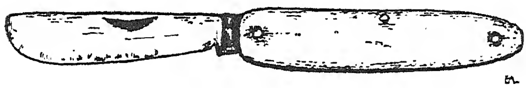

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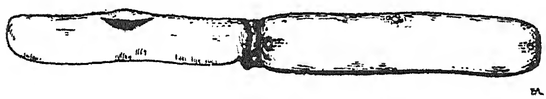

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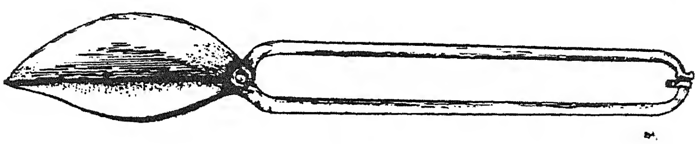

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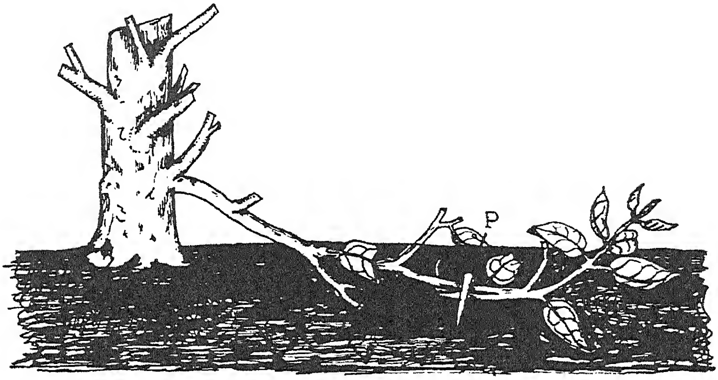
PLATE 4.

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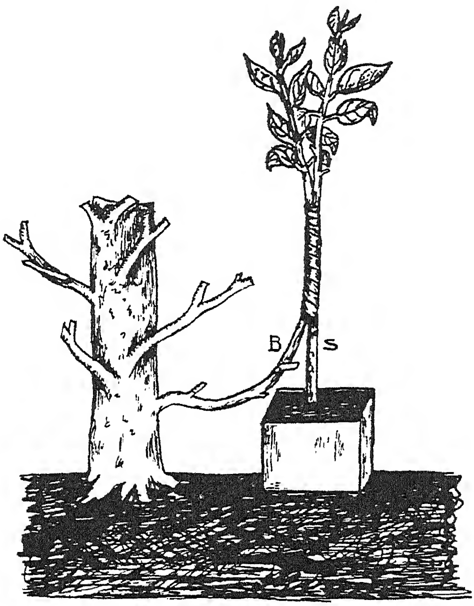


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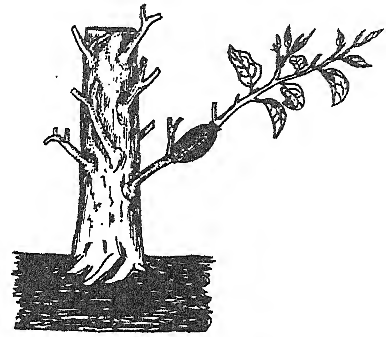
PLATE 5.



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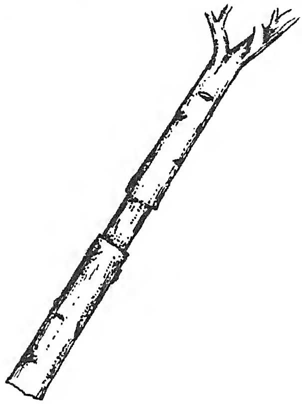

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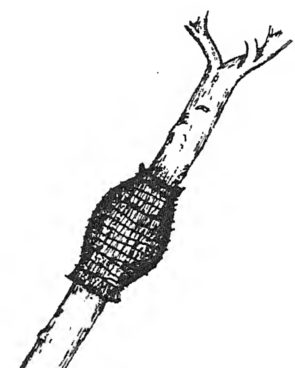

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PLATE 6.

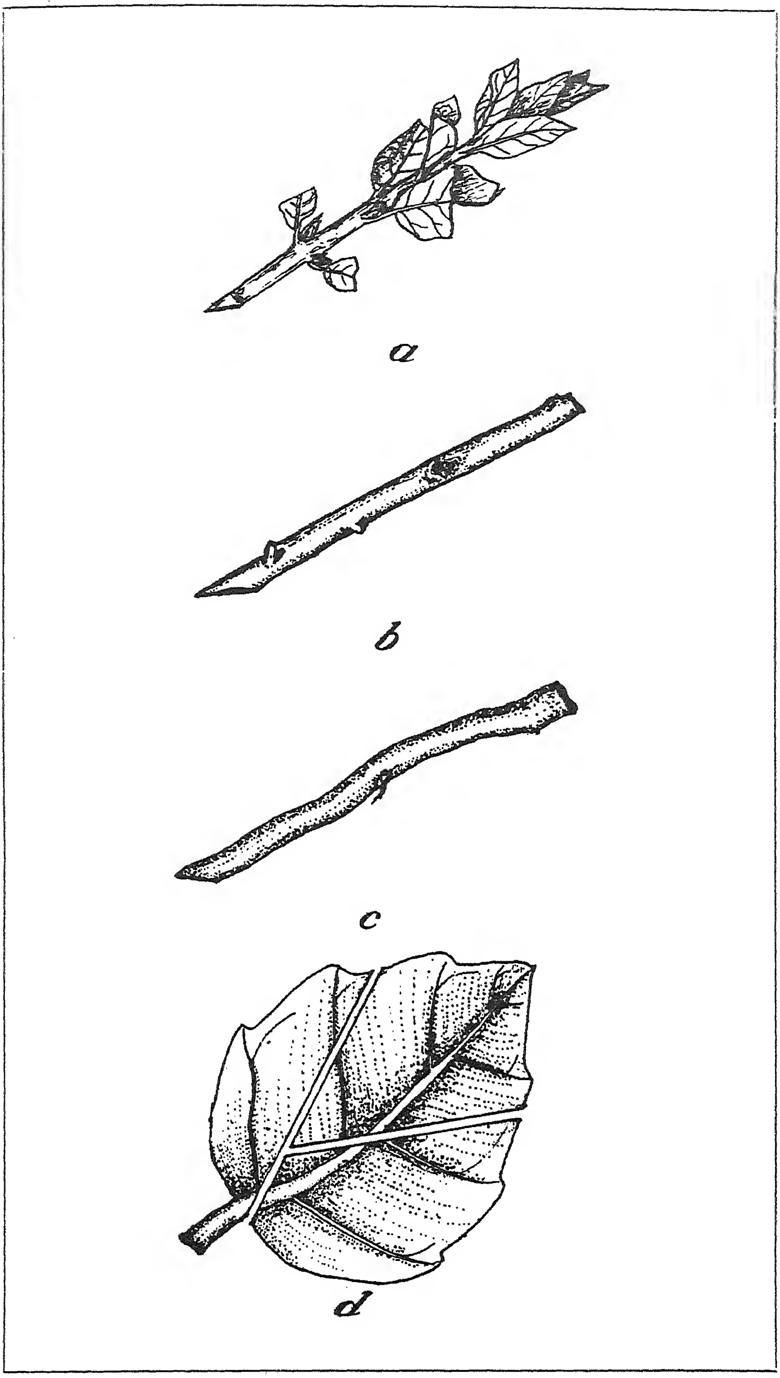


PLATE 7.

# BOOK REVIEW

We have just received a copy of the Technical Communication No. 7 of the Imperial Bureau of Fruit Production, East Malling, Kent, England, entitled "Vegetative propagation of tropical and subtropical fruits" by G. St. Clair Feilden. The author begins his subject by describing and illustrating the different methods of vegetative propagation such as budding (flute or modified patch, forkert or modified forkert, patch, ring and shield budding), etiolation method, grafting (saddle, side, tongue, slotted side, splice, wedge and whip grafting), inarching, layering and marcotting together with the preparation of grafting wax and the petioled and non-petioled budwoods. The first part is of particular interest to the students in horticulture who want to be familiar with the different methods of vegetative propagation now in practice.

The second part of the paper deals mainly with the vegetative propagation of the various tropical and subtropical fruit trees including the stock plants. This portion is of exceptional value to the orchardists since it enumerates not only the best stocks and scions for each of the mentioned fruit trees especially the varieties with economic value in the Philippines like the mangosteen, lanzon var. duku, mango, avocado and chico. Besides the right time and methods of propagation suited for them basing upon the results obtained in Java, India, Ceylon, Philippines, Hawaii, United States and elsewhere. However, mention should be made that the compilations herein under review do not include the Philippine results reported after Wester's work had been published in 1920, Bul. 32—The Plant Propagation and Fruit Culture in the Tropics—as regards vegetative propagation experiments conducted by the Bureau of Agriculture, now Bureau of Plant Industry, as published in the Philippine Agricultural Review, Vols. 13 and 17 (1920 and 1924), the Philippine Farmer, Vol. 6 (1920), and the Philippine Journal of Agriculture, Vol. 2, No. 4 (1931).

Special emphasis should be mentioned as regards the possibility of budding or grafting the mango and avocado embryos, and the success made in Martinique in grafting the mango on cashew, *Anacardium occidentale* L., which according to the author, the resulting plants were reported to have produced fruits double in size, free from fiber and with very small seeds.

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# SCLEROTIUM WILT OF PEANUT, WITH SPECIAL REFERENCE TO VARIETAL RESISTANCE [1]

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TWENTY-TWO PLATES AND FIVE TEXT FIGURES

The control of plant diseases by immunization is dependent upon the availability of varieties which possess resistance and satisfactory agronomic characters. The object of the investigation reported in this paper was to isolate a pure line variety or strain of peanut, *Arachis hypogæa* Linn., highly resistant, if not immune, to the wilt disease caused by *Sclerotium rolfsii* Sacc. This disease is probably the most destructive malady of peanut known in the Philippines. In spite of the fact that the fungus *Sclerotium rolfsii*, has been recorded on peanut in the Philippines since 1918 (Table 5), there has been no published account

[1] Thesis presented, 1937, to the Committee on Graduate Studies, University of the Philippines, in partial fulfillment of the requirements for the degree of Master of Science. A part of this paper was read before the Fourth Philippine Science Convention on February 25, 1937, Manila, P. I.

[2] The writer desires to express his grateful appreciation to his adviser, Professor José K. Santos, Head, Department of Botany, University of the Philippines, for his interest during the latter part of the work and for his helpful suggestions and criticisms; and to Dr. Gerardo O. Ocfemia, Head, Department of Plant Pathology, College of Agriculture, Los Baños, Laguna, for reading the manuscript. Thanks are also due Mr. Juan O. Unite, of the Plant Breeding Section, Bureau of Plant Industry, for the varieties made available for this study and for his coöperation in laying out the first field experiment.

of peanut wilt prior to October, 1933. The present paper reports mainly the results of trials on relative resistance to *Sclerotium rolfsii* of local commercial varieties and certain exotic forms. This work was started in view of the seriousness of the disease which has not been heretofore carefully studied in the Philippines, the increasing use of peanut in the diet of the Filipinos, and the value of the vines for stock feed and of the root nodules for soil renovation.

Peanuts are grown in small holdings all over the Islands. According to June 30, 1935 figures, the Philippines produced 1,341,410 kilos of peanut valued at ₱316,890 [3]. As this production does not fully cover the needs of the people large quantities of peanut are imported annually from abroad (1,281,172 kilos in 1935 valued at ₱132,409, and peanut oil worth ₱71,123).[4]

In order to increase the production of peanuts in the Philippines it seems necessary to plant peanut both in the wet and in the dry season. At both times of the year, however, peanuts are attacked by Sclerotium wilt and by other diseases and their combined effects may reduce the yield considerably if allowed unchecked. In view of the widespread occurrence of *Sclerotium rolfsii* in the Philippines not only on peanuts but also on many host plants, the use of resistant varieties seems to be the ultimate solution of the control problem. The control of plant diseases by planting resistant varieties is the most economical, most effective and permanent measure.

The possibilities in the Philippines of the peanut industry which is "still in its primeval stage" [5] is very great. As stated above our production of peanuts cannot supply the local consumption so that large quantities are imported annually from other countries. The prospects of good market abroad is said to be bright. According to John D. McCord, president and general manager of the Blue Bar Dessicated Coconut Company, peanut oil is gradually replacing dessicated coconut product in confectioneries in the United States.[6] Bigger and better nuts are also very much in demand.[7]

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[3] Philippine Statistical Review, No. 3, Vol. 3, 1936. Bureau of Printing, Manila.

[4] Figures furnished by the Statistics Division, Department of Agriculture and Commerce.

[5] Manila Daily Bulletin, June 27, 1935.

[6] The Tribune, August 14, 1935.

[7] Manila Daily Bulletin. Ab. Cit.

The investigation reported in this paper was conducted from October, 1933 to December, 1936, inclusive, in the experimental plats of the Bureau of Plant Industry at San Andres, Manila.

## REVIEW OF LITERATURE

### DISTRIBUTION AND ECONOMIC IMPORTANCE OF THE DISEASE

Of the diseases of peanut in the Philippine, the Sclerotium wilt seems to be the most serious. Losses from this disease are difficult to estimate but it is without doubt greater than that caused by any other peanut disease. The distribution of the disease was reported by Reyes and Ramos(37) in April, 1935, and by Fajardo(14) about the end of the same year.

Field observations made of peanut varieties grown side by side in the plats of the Bureau of Plant Industry Central Experiment Station in the wet season of 1933, showed that Sclerotium wilt (Plate 1) was rampant. Examinations made by Reyes and Ramos(37) in October, 1933, showed that all of the seventeen varieties were affected in degrees of seriousness varying from 5.0 to 50.7 per cent. Plants attacked at an early stage generally produced no peanuts and those infected after peanuts have developed pods usually failed to mature. Pods which have already reached maturity may be infected both externally (Plate 2) and internally (Plate 3). In some cases only one or more wilted shoots occur in a hill, while in others entire hills (Plate 1) may be killed. While the disease is very common during the wet season, it also causes considerable injury during the dry season.

In the Philippines, Reinking(34) reported a *Sclerotium* causing a rot of the basal portion of the stems and of the root of peanut. According to this author the disease usually causes no great damage. Pereira(32) isolated a species of *Sclerotium*, probably *S. rolfsii*, from peanut, rice, carrots and sugar cane. Fajardo(14) reported percentages of infection in certain places in Luzon, Philippines, varying from "a trace to 50 per cent" on "tomatoes, peanuts or beans," and "5 to 20 per cent" on "tomato, peanuts and eggplants."

In other countries considerable losses on peanut have been attributed to the ravages of *Sclerotium rolfsii*. In the United States, Wolf (1914)[8], McClintock(22), and Beattie and Beattie(5) are in full accord in regard to the economic importance of *Sclerotium rolfsii*.

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[8] Cited by Miller and Harvey (23).

To Saccardo(40) belongs the credit for having first recorded the genus *Arachis* as a host of *S. rolfsii.* According to Peltier(31), however, the first report of the occurrence of the Sclerotium disease of peanut was made by Rolfs from Florida in 1893. Peltier(31) first reported an outbreak of this fungous disease on cultivated perennials in the northern United States. Nine years after Rolfs found the fungus in Florida, Saccardo(40) described it as a new species, *Sclerotium rolfsii.*

In 1914, F. A. Wolf of the Alabama Agricultural Experiment Station reported a fruitrot of peanuts caused by *Sclerotium rolfsii* Sacc.[9]

McClintock(22) reports wilted peanuts at the Virginia Truck Experiment Station also caused by *S. rolfsii.* This author believes that the fungus must have been introduced with imported seeds. The Sclerotium disease of peanut was first observed in Virginia in 1913 and the number of diseased plants increased subsequently every year thereafter. In 1916, the disease caused 15 per cent of wilting of Valencia variety grown in the experimental plats.

In the United States, Anderson(1) attributed to *Sclerotium rolfsii* the stem rots of some 44 economic plants. The same author reported that *S. rolfsii* is common on peanuts in southern States. In 1931, Beattie and Beattie(5) attributed as much as 10 to 15 per cent of losses of peanut pods to root rot caused by *S. rolfsii.* In 1932, Miller and Harvey(23) state that this disease has been overlooked in Georgia as a common cause of root and stem rot of peanut.

Brief scattered reports of the occurrence of this peanut disease in other peanut-growing countries give but scant estimates of losses. According to Maublanc(21) peanut in the French colonies in West Africa is attacked by *S. rolfsii.*

In 1925, the Department of Agriculture in South Africa(2) reported severe outbreaks of wilt of groundnuts due to *Sclerotium rolfsii* in Transvaal.

Shepherd(41) in 1926 mentioned the occurrence on groundnuts in Mauritius of a fungus resembling *Sclerotium rolfsii.*

Rhind(38) in 1927 stated that *S. rolfsii* attacks peanut in damp localities in Burma. In the same year, peanut wilt caused by *S. rolfsii* was recorded by Hansford(15) in Uganda. Leefmans(19) reports that this fungus causes as much as 10 per cent damage to peanuts in the Netherlands Indies.

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[9] Cited by Miller and Harvey (23).

Bertus[6] reports *Sclerotium rolfsii* on groundnut in Paradeniya, Ceylon. The fungus attacks the plants at ground level or above it, causing the leaves and stalks to wither. From his inoculation experiments Bertus concluded that *S. rolfsii* causes stem infection only when a humid atmosphere prevails. He further concludes that generally the fungus is a weak parasite and does not affect underground parts.

Thompson[44] in 1928 reported *S. rolfsii* in Malaya and groundnut was among its hosts listed.

In Sierra Leone in 1929, Deighton[11] stated that *S. rolfsii* attacks peanut in several localities.

In Guatemala, Palm[27] reported in 1932 that groundnuts are attacked by *S. rolfsii.* In Madagascar in the same year, Bouriquet[9] reported *S. rolfsii* as a disease of groundnut as early as 1929.

Marchionatto[20] observed groundnuts attacked by *S. rolfsii* in the Argentine since 1929.

Although *Sclerotium rolfsii* has a worldwide distribution, there seems to be a meager account of the disease and losses that it causes on peanut. In European countries there seems to be no reference in the literature to Sclerotium wilt of peanut. The geographical distribution of the fungus, however, points to the fact that the wilt is an important disease of peanut. It further shows how varied are the conditions and climes under which the fungus can exist, and how numerous are its hosts.

## EFFORTS DIRECTED TO CONTROL THE DISEASE

Very little attention has been given to diseases of peanut in the Philippines especially in regard to control measures. This situation accounts partly for the spread of the *Sclerotium rolfsii* disease with greater or less severity each year.

In the Virginia Truck Experiment Station, McClintock[22] reports that a rotation of more than three years is not sufficient to starve out *Sclerotium rolfsii* in the soil. In a test of six varieties for resistance conducted in a soil badly infested with *S. rolfsii* the same author found that Valencia was the most susceptible, and that the order of resistance of the other varieties are Spanish, Tennessee Red, and Virginia Bunch, while Virginia Runner, African, and Hog Goober (*"Worandzia subterranea"*) were practically immune.

Miller and Harvey[23] recommend that the best method of controlling the disease is by the cultivation of resistant varieties, like Alabama Runner in place of susceptible White Spanish.

From the results of his field observation and inoculations, Bertus(6, 7) recommends certain eradicatory measures, such as the burning of diseased plants *in situ;* collection and burning of dead or decaying vegetable matter; and burying the sclerotia in holes or trenches to a depth of 9 to 12 inches.

Beattie and Beattie(5) recommend crop rotation with corn, cowpeas, rye and clover, but not with cotton, sweet potato, potatoes, tomatoes, or cucumbers.

## MATERIALS AND METHODS

### VARIETIES AND STRAINS USED AND THEIR SOURCES

As a result of encouraging field observations made by the writer in October, 1933, and in 1934, an attempt was made in 1934, 1935 and 1936 to determine definitely whether or not differences in resistance to *Sclerotium rolfsii* exist in peanut varieties. From a total of seventeen varieties observed for the presence of *Sclerotium rolfsii* infection in the wet season of 1933, twelve varieties were used (1) for showing less disease infection, (2) for giving fairly good yields, (3) for having desirable type of kernel and color of seed coat, (4) for habit of growth, or (5) for exhibiting luxuriant green foliage. No consideration was given to oil content or seed dormancy in making the preliminary selection.

The seeds of varieties used in all experiments (Table 1) were raised by and obtained from Mr. Juan O. Unite of the Plant

TABLE 1.—*Origin of the peanut varieties used for the experiments recorded in this paper and their habit of growth*

| Variety, number and name | Date of introduction | Source | Habit of growth |
|---|---|---|---|
| 1. Biit | 1930 | Pangasinan | Decumbent |
| 2. Cagayan No. 1 | 1923 | Tuguegarao, Cagayan | Do. |
| 3. Georgia Red | Mar. 24, 1933 | Oneco, Florida, U. S. A. | Do. |
| 4. Macapno | 1923 | Lamao Horticultural Station, Limay, Bataan. | Do. |
| 5. San José No. 3 | June 3, 1933 | Cabanatuan, Nueva Ecija | Do. |
| 6. Spanish | October, 1913 | Richmond, Virginia | Do. |
| 7. Tai-tau | May 19, 1933 | Lingnan University, Canton, China. | Runner |
| 8. Tirik | 1930 | Lemery, Batangas | Semi-erect |
| 9. Valencia | June 3, 1922 | College of Agriculture, Los Baños, Laguna. | Semi-runner |
| 10. Vigan Lupog | June 3, 1922 | do | Semi-erect |
| 11. Virginia Jumbo | Mar. 24, 1933 | Oneco, Florida, U. S. A. | Runner |
| 12. Virginia Jumbo (a) | 1930 | Lamao Horticultural Station, Limay, Bataan. | Do. |
| 13. White Improved Spanish | Mar. 25, 1933 | Oneco, Florida, U. S. A. | Decumbent |

Breeding Section, Bureau of Plant Industry. As may be seen in Table 1, six of these varieties are apparently native and six are of foreign origin. Tai-tau variety which was added to the list in the last two tests, was of recent introduction from China. Apparently this is the big-seeded variety which is commonly seen for sale in the Chinese stores. Two varieties, Tai-tau and Virginia Jumbo, and a strain of the latter are of the runner type, while the others are semi-erect, semi-runner, or mostly decumbent in habit of growth.

METHOD OF APPROACHING THE PROBLEM

While the primary object of these studies was to evaluate the relative resistance of peanut varieties to the attack of *Sclerotium rolfsii,* a thorough survey of the losses occasioned by this fungus disease in the field in various parts of the Philippines was also made. Fortunately a fairly good collection of varieties in culture at the Plant Breeding Section of the Bureau of Plant Industry afforded a splendid opportunity for making the necessary field observation, and for comparison of resistance or susceptibility of varieties. Further information in regard to the seriousness of the disease in the field was obtained through the writer's colleagues in the Plant Pathology Laboratory of the Bureau of Plant Industry. This information gave the writer a sufficiently representative opinion of the seriousness of the Sclerotium disease, and the expediency in solving this plant-disease problem.

In order to test the different varieties under partially controlled conditions, a number of isolations of *S. rolfsii,* were made from all sources and from all available varieties. The cultures were previously tested for pathogenicity to see whether or not differences exist among the cultures. For purposes of uniformity, however, only one isolate from a variety showing a fairly high degree of infection was consistently used throughout artificial field-infection tests.

Properly cured seeds were secured for planting according to the field plan shown in Fig. 1. In this figure the arrangement of plats and the distance of planting of varieties listed in Table 1 were followed.

The relative susceptibility of native and introduced peanut varieties to *Sclerotium rolfsii* were tested by artificial inoculation. The peanut varieties used represented different types of growth and maturity periods. Trials were also made at different seasons in order to determine what environmental factors are conducive to the occurrence and severity of the disease.

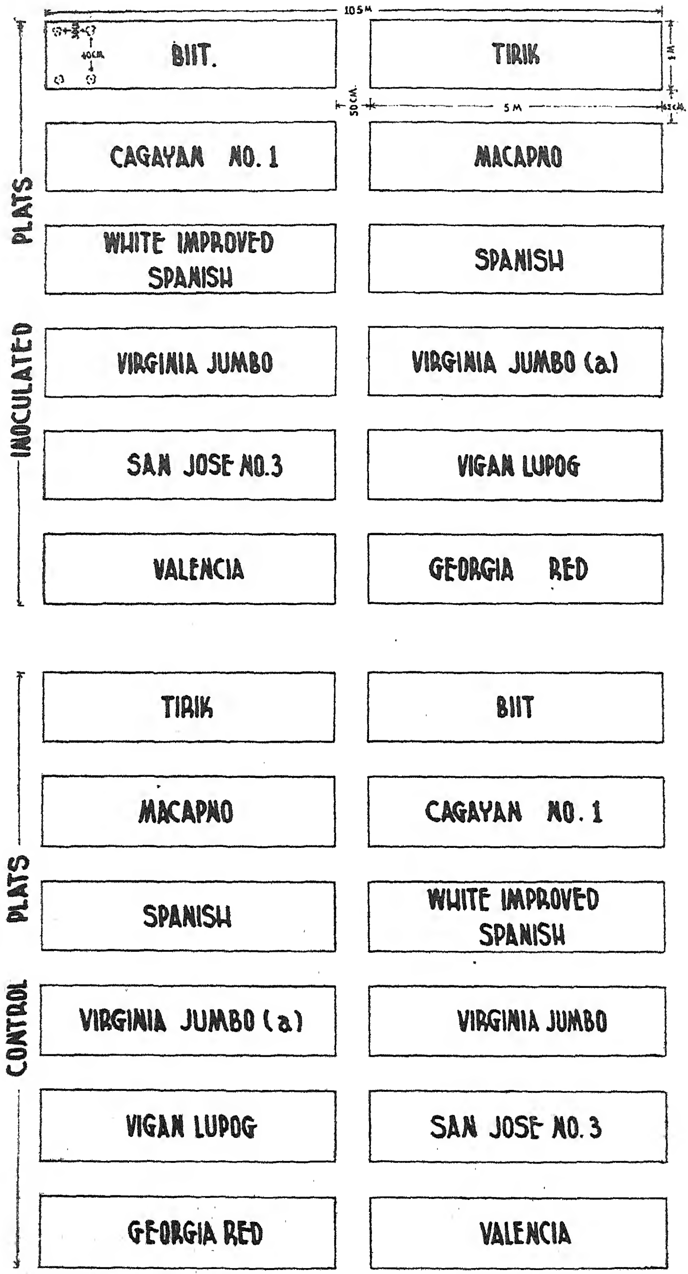


FIG. 1. Plan of the experimental field, showing the arrangement of plats, distribution of the varieties, and distancing. [a]

[a] Tai-tau variety was added to the list in subsequent trials, 1935 and 1936.

In view of the cosmopolitan nature of this soil organism great stress was given to the study of the relative resistance of varieties. Incidentally the relations of cultural practices in vogue and types of soil were also taken into account.

## EXPERIMENTS AND OBSERVATIONS

### THE DISEASE

*Name.*—The disease of peanut caused by *Sclerotium rolfsii* has been reported under the names of "wilt," "fruit rot," "sclerotial rot"[10] "sclerotial disease," "stem rot," "blight," "southern blight,"[11] or simply "rot." To distinguish the trouble from other peanut diseases and to avoid confusion, because other organisms also cause wilt of peanut the name "Sclerotium wilt" seems to be the most appropriate. The name is not only the most appropriate because it is more inclusive, simple and clear, but it is also the most tenable because the association of the fungus with wilting is the first and most reliable symptom of infection. An all-inclusive name for this disease should perhaps be "Sclerotium disease of peanut."

*General characters.*—The general appearance of this disease in the early and advanced stages is shown in Plates 1, 8 and 13. The first symptom of the disease is the wilting of the upper portion of the twigs as if affected by drought. Wilting is followed by drooping of the foliage and losing of the normal green color. The fungus attacks the stems and crown roots near the ground level. The mycelium invades the cortex, girdles the stems, turns it dark brown, permeates the tissues of the stem upwards, and causes the stem to shrink and die. It also invades the underground parts, such as the pegs, pods (Plate 3) and roots. On careful examination shrunken discolored areas may be seen. Under favorable conditions, pods formed near the crown of infected plants are usually covered either partly or wholly with the white mycelium. Plants attacked may be partially or totally infected and never recover.

Branches, leaves and young pods near the surface of the ground are attacked and copious, white, coarse, dense mat of radiating mycelium may be seen on the soil immediately surrounding the infected parts. In a short time, small white spherical bodies form copiously on the surface of the affected tissues. The sclerotial bodies later become buff- or brown-

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[10] Cited by Taubenhaus (43). [11] Cited by Stevens (42).

colored. Occasionally, in light soils and during the dry season, the growth of mycelium may be confined to the underground parts of the plant. Sclerotia develop underground near the surface or in crevices. The coarse, white mycelium and the sclerotia of the fungus may also be seen on the shell (Plate 2), or inside the infected, cracked pods (Plate 3). Rotting of the infected cotyledons invariably takes place. In some cases severely infected plants produce no marketable pods.

### ISOLATION, PATHOGENICITY, AND IDENTITY OF THE CAUSAL FUNGUS

*Isolates from different varieties.*—The causative organism was isolated from different wilted varieties of peanuts, scattered in the field. Portions of infected basal parts were cut under aseptic conditions, disinfected, washed and then plated out on potato-glucose agar. From the cottony-white growths that developed, subcultures were made into tubed potato-dextrose agar. Pure cultures were also easily obtained from white, yellow or brown sclerotial bodies adhering to the affected plants.

TABLE 2.—*Isolations of Sclerotium rolfsii Sacc., from peanut varieties and from various places*

| Variety | Source | Affected part | Date of isolation |
|---|---|---|---|
| 1. Biit | Central Experiment Station, Manila. | stem | Oct. 31, 1933 |
| 2. Cagayan No. 1 | do | stem | Oct. 31, 1933 |
| 3. Georgia Red | do | stem | Oct. 31, 1933 |
| 4. Macapno | do | stem | Nov. 2, 1933 |
| 5. Tirik | do | stem | Nov. 2, 1933 |
| 6. Valencia | do | stem | Nov. 2, 1933 |
| 7. Virginia Jumbo | do | stem | Nov. 2, 1933 |
| 8. Peanut plant | Antipolo, Rizal | stem | Sept. 2, 1935 |
| 9. Peanut plant | Lipa, Batangas | stem | January, 1935 |
| 10. Peanut plant | Malinao, Albay | stem | Sept. 22, 1936 |
| 11. Peanut plant | Tubigon, Bohol | stem | Nov. 17, 1936 |

The diseased tissues were placed overnight in sterile chambers supplied with moist cotton and the sclerotial bodies were transferred to steamed rice or cornmeal either with or without sterilization. Both methods proved to be satisfactory although occasional bacterial contaminations were observed. The isolates obtained from the various varieties and their sources are listed in Table 2. All the peanut wilt *Sclerotium* isolated from the different localities and varieties were maintained in pure culture for comparative purposes. They looked so similar in their characteristic features that it was not possible to differentiate

one from another when grown on the same media under laboratory conditions.

*Infection experiment.*—Artificial infection experiments in the greenhouse using young peanut plants (Plate 6) grown from sterilized seeds in duplicate pots of sterilized soil, and field experiments with pure cultures of the organism proved beyond doubt that the fungus is pathogenic. The inoculation was performed by placing about the same-sized blocks, cut in young plate cultures of the organism, on the soil surface in contact with the stem. The symptoms of the infected plants (Plate 6, figs. 1 and 2) appeared identical with those found on naturally infected peanut plants. The fungus caused wilting and produced copious white mycelium, with distinct radial growth (Plate 6, fig. 1) on the soil surrounding the infected part. Reisolations yielded the same kind of organism. In the greenhouse infection was much slower and caused no material injury probably due to high temperatures and dryness of the atmosphere at the time of the experiment. The peanut plant was found subject to infection during its entire life time, but it is more susceptible during early growth. The organism requires a certain amount of soil moisture and air humidity.

During the dry season peanut plants grown in the greenhouse were infected only partially and with considerable difficulty. In the open, intermittent rains and sunshine facilitated infection. Inocula obtained from young growths, without sclerotia, produced infection much quicker than sclerotial bodies. Wilting is considerably delayed under environmental conditions unfavorable for infection. The same symptoms were produced and the same fungus was reisolated from the sclerotia and diseased tissues of infected plants. The control plants showed no symptoms and signs of the disease whatsoever.

*Measurements of sclerotia obtained from pure cultures and from the field.*—Cultures of this peanut *Sclerotium* obtained from time to time from diseased plants of different varieties and localities grew readily on various media. In all cases the growth was typical of *S. rolfsii* Sacc. They produced coarse, white, fan-shaped vegetative growth in culture on dapdap (*Erythrina variegata* Linn, var. *orientalis* [Linn.] Merr.) leaves (Plate 4). In a short time, this white mass of mycelia becomes dotted with white tufts originating from a plexus of interlacing hyphae, and finally develop into brown spherical sclerotia. The sizes of the light to dark brown easily detached spherical bodies,

obtained from peanut in the field and from pure cultures (Plate 5), are given in Table 3.

The brown sclerotial bodies on dead tissues of peanut obtained from the field were much smaller than those produced in pure cultures. They measure from 0.28 to 0.99 millimeter. Although the range in size of sclerotia in nature varies to some extent, yet the average size computed on 100 measurements differs only slightly, or 0.50 to 0.56 millimeter.

TABLE 3.—*Diameters of sclerotia based on 100 measurements*

| Source | Range | | Average |
|---|---|---|---|
| IN NATURE | $\mu$ | *mm* | $\mu$ *mm.* |
| Peanut tissues | 280–840 | 0.28–0.84 | 560.0 or 0.56 |
| Cagayan | 360–690 | 0.30–0.69 | 500.6 or 0.50 |
| Georgia Red | 310–690 | 0.31–0.69 | 504.4 or 0.50 |
| Spanish | 400–670 | 0.40–0.67 | 524.6 or 0.52 |
| Valencia | 340–990 | 0.34–0.99 | 555.4 or 0.55 |
| IN CULTURE | | | |
| Potato-glucose agar | 600–2600 | 0.60–2.60 | 1,200.0 or 1.20 |
| Sterilized dapdap leaves | 500–1400 | 0.50–1.40 | 1,390.0 or 1.39 |

Saccardo's(40) figures for the sizes of sclerotia (0.5–0.8 mm. diameter) of *S. rolfsii*, fall closely within the writer's range of measurements of sclerotia from stems of four varieties.

From pure cultures the sclerotia were much larger having a much wider range and an average of 1.2 millimeters on potato-dextrose agar and 1.39 millimeters on sterilized dapdap leaves (Plate 5). The sizes and shapes of sclerotia of more than thirty cultures of *S. rolfsii* by the writer, varied according to environmental conditions, and chemical or nutritive constituents or reaction of media.

*Comparison with authentic cultures and published descriptions.*—The growth in pure culture and the morphological characters of the writer's fungus agree very closely with the description by McClintock(22) of *Sclerotium rolfsii* Sacc. on peanuts, especially in regard to size, shape and color of sclerotia. The general appearance of the fungus agrees with the *S. rolfsii* described by Higgins(16) and Taubenhaus(43). The morphologic features of sclerotia, host preference, and behavior in nature are as described by Saccardo(40). It seems unnecessary to redescribe the morphological characters here. According to Pereira,(32) the *Sclerotium* cultures he isolated from peanut, rice, carrots and sugar cane looked so similar that it was impossible

to distinguish one culture from the other when grown under the same conditions. The mycelium was said to have closely similar morphological characters. A comparison of the cultures isolated from peanut and growing on the same medium, at the same age and under identical conditions was made with an authentic culture of *S. rolfsii* Sacc. The authentic culture was kindly supplied by Dr. B. B. Higgins of the Department of Botany, Georgia Agricultural Experiment Station, United States. No well-defined differences, both in mycelial characters and in physiological reactions could be noted. The writer believes that the peanut wilt fungus under discussion is identical with *Sclerotium rolfsii* Sacc.

## FIELD OBSERVATIONS

*Reports of outbreaks of Sclerotium wilt.*—The destructive ravages of this disease in various parts of the Philippines, generally appears in certain localities during the rainy or sultry days of August and September, extending even to the early part of November.

In Albay Province, Assistant Pathologist Melanio R. Calinisan estimated that the disease caused as much as from 60 to 70 per cent of damage. Macario A. Palo, also of the Plant Pathology Laboratory, Bureau of Plant Industry, reported that it is the most common disease of peanut in Batangas Province.

Another evidence of the destructiveness of this peanut disease was learned from Plant Sanitation Foreman Diosdado S. Bongato of the Bureau of Plant Industry, on November 11, 1936. According to Mr. Bongato the disease appeared in Tubigon, Bohol, causing not only wilt and death of peanuts but also decay of the pods.

*Percentages of natural infection obtained by actual counts.*—In the dry season of 1934 the infection of five varieties of peanuts by *S. rolfsii* in the same field previously planted to peanuts was considerable. Forty-nine days after planting, counts of plants affected with the Sclerotium wilt disease were made at weekly intervals until April 5, 1934. The percentages of infection varied from 31.3 to 50.7 per cent (Table 4) according to the variety. The result tends to show that continuous planting in an infected field increases the incidence of the disease. Although only a few (1–6) hills were severely affected and died completely, the percentage of infection shows that under most favorable conditions the disease may cause a severe damage.

TABLE 4.—*Relative susceptibility of peanuts to S. rolfsii observed under natural conditions*

| Variety | Date planted | Number of plants | | Per cent infection |
|---|---|---|---|---|
| | | Observed | Infected Apr. 5, 1934 [a] | |
| Biit | Dec. 8, 1933 | 69 | 35 | 50.7 |
| Macapno | Dec. 8, 1933 | 66 | 24 | 36.3 |
| Spanish | Dec. 8, 1933 | 65 | 29 | 44.6 |
| Tirik | Dec. 8, 1933 | 67 | 21 | 31.3 |
| Virginia Jumbo | Dec. 8, 1933 | 12 | 0 | 0 |

[a] Last date of observation.

*Evidence of varietal differences in susceptibility to disease.*—Practically every one of the seventeen varieties of peanut grown in the wet season of 1933 in the Central Experiment Station of the Bureau of Plant Industry in Manila was attacked by Sclerotium wilt in varying degrees of severity. At the beginning of the rainy weather, plants infected with *Sclerotium rolfsii* were found wilting here and there and in October, 1933 many plants were dead. Fluffy, white mycelial growths were present on newly infected plants and sclerotial bodies were visible around the base of the dying or dead plants, or on the soil which was more or less baked, strongly indicative of its acid condition. Evidence so far obtained, however, indicates that there is considerable difference in susceptibility. The writer noted differences of 5 per cent or more among the various peanut varieties grown side by side during this season at the Central Experiment Station of the Bureau of Plant Industry. Virginia Jumbo, seemed to possess sufficient resistance. In a preliminary selection, five of the seventeen varieties observed in the wet season of 1933 were eliminated. The reason for the elimination was either for undesirability of characters or for susceptibility to *Sclerotium* infection. Twelve varieties were selected and used in disease-resistance experiments.

*Methods of dissemination.*—The brown sclerotia of the fungus may be around the infected parts, on the soil surrounding the base of the plant, and on fallen leaves and dead stems. The sclerotia drop off easily from dead host tissues and thus on the soil they may be scattered from place to place by water, human beings, animals, implements and other agencies. These sclerotia perennate in the soil for a long period and are reactivated, when climatic and soil conditions become favorable.

These sclerotia together with those which adhere on dead plant tissues are sources of infection in subsequent plantings. As the fungus is soil-borne, it can be readily transferred with the soil from place to place.

Peanut pods and infected stems harboring the mycelium or sclerotia are liable to spread the disease to succeeding crops. Careful selection of well developed seeds from healthy plants is therefore of prime importance. Spread of the fungus from plant to plant may be by contact between diseased stems and leaves and by the mycelium which develops from scattered sclerotia or through the soil, especially if the latter is of light texture.

The fungus sclerotia may also be scattered by farm animals, such as cattle and sheep, for considerable distances. It has been found by Leach and Mead(17) that the sclerotia remain viable after their passage through the digestive tract of such animals. The carabao, and the goat, as well as other farm livestocks, should prove equally dangerous in the introduction of infection into disease-free areas.

*Factors affecting occurrence and severity of the disease.*—Peanuts are generally grown in most provinces in the Philippines only once a year. The seeds are planted in May or June or after the first showers. In other words peanut is generally a wet season crop, and varieties are sown without regard to whether or not they are early maturing, intermediate, or late, in soils with no tendency to stay wet. Some provinces, however, grow peanuts during the dry season, or where there is a moderate amount of rainfall.

Field observations and inoculations in the greenhouse indicate the influence of environment upon the development of the disease. Like most plant diseases the Sclerotium wilt of peanut occurs more seriously during the wet season than during the dry season. It is probably for this reason that wet season crops occasionally produce lower yields as found in the experiments of Battung(4).

Peanut is subject to infection during its entire life time, although it is more susceptible at the seedling stage. The development and spread of the disease seem to be influenced by the growth of the seedlings. When the growth is below normal, the seedlings are generally more ravaged by the disease than when their growth is rapid. Close planting favors its spread greatly.

During rainy periods the disease is often shown at an early stage by the appearance of white mycelium creeping on the sur-

face of the ground and on the stems of peanut. If favorable weather and soil conditions prevail, the progress of the disease is so rapid that it may kill entire hills (Plate 1) or big areas affecting also the underground parts (Plates 2 and 3). If rainfall is not uniform, the progress of the disease may be arrested for lack of soil moisture and only partial infection occurs. The amount of moisture in the soil and the development of the fungus determine the extent of infection. These factors also determine the spread of the fungus mycelium through the soil, from plant to plant in the row. Plants growing in low wet places are generally severely ravaged by the disease.

Of the many varieties attacked by the disease in the field and of the few sorts artificially inoculated also in the field, all have shown susceptibility to the disease. One or two varieties, however, proved to be comparatively resistant to it.

Light loam soil favors the development of the organism probably because of greater air spaces and of the presence of abundant organic matter. The migration of the fungus from one plant to another or from row to row is facilitated in this kind of soil.

### OTHER PLANTS ATTACKED IN THE PHILIPPINES AND ELSEWHERE

The *Sclerotium* fungus causing wilt on peanut is a widespread organism and it attacks a wide variety of host plants including annuals and perennials, herbaceous and woody, important economic crops as well as ornamentals, and weeds. It is most frequently observed on herbaceous and leguminous crops probably by their relative succulence. A list of susceptible species of plants reported by various investigators in the Philippines is given in Table 5.

This list (Table 5) gives a single report on each host infected naturally and only host plants recorded for the first time. The reports of Reinking(34, 35) and also of Pereira (32) did not state definitely the species of *Sclerotium* causing disease on various hosts, but it seems very probable that these authors dealt with *S. rolfsii*. Tisdale(45) confirmed the *Sclerotium* disease of rice in the Philippines as due to *S. rolfsii* Sacc.

In plant disease surveys made by the writer, a few other suscepts may be added to the already known plants reported to be attacked by *Sclerotium rolfsii* in the Philippines. Besides peanut, banana, "buñga ñg tubó" (*Aeginetia indica* Linn.), wheat, eggplant, everlasting, rice, sugar cane, etc., which are already

TABLE 5.—*Host range of Sclerotium rolfsii Sacc. recorded in the Philippines, arranged chronologically and in alphabetical order of the common names.*

| Authority | Year reported | Host plants: Common name | Host plants: Botanical name |
|---|---|---|---|
| Reinking (34) | 1918 | beans | *Phaseolus* spp. |
| | | citrus | *Citrus* spp. |
| | | coffee | *Coffea* spp. |
| | | peanut | *Arachis hypogæa* Linn. |
| Reinking (35) | 1919 | alfalfa | *Medicago sativa* Linn. |
| | | African peanut | *Voandzia subterranea* Thou. |
| | | gabi | *Colocasia esculentum* Schott. |
| | | soybeans | *Glycine max* (Linn.) Merr. |
| | | sweet potato | *Ipomœa batatas* (L.) Poir. |
| | | yautia | *Xanthosoma sagittifolium* Schott. |
| Lee (18) | 1922 | sugar cane | *Saccharum officinarum* Linn. |
| | | tobacco | *Nicotiana tabacum* Linn. |
| Pereira (32) | 1922 | rice | *Oryza sativa* Linn. |
| Ocfemia (25) | 1924 | pepper | *Capsicum annuum* Linn. |
| | | tomato | *Lycopersicum esculentum* Mill. |
| Atienza (3) | 1927 | apong-apong | *Amorphophallus campanulatus* (Roxb.) Blume |
| | | avocado | *Persea americana* Mill. |
| | | Jerusalem artichoke | *Helianthus tuberosus* Linn. |
| | | patola | *Luffa acutangula* (L.) Roxb. |
| | | sitao | *Vigna sesquipedalis* Fruw. |
| | | squash | *Cucurbita maxima* Duch. |
| Palo (29) | 1928 | onion | *Allium cepa* Linn. |
| De Mesa [a] | 1930 | bagilumbang | *Aleuritis trisperma* Blanco |
| Fajardo (12) | 1933 | amarylli lily | *Hippeastrum* sp. |
| | | Amazon lily | *Eucharis grandiflora* Planch. & Linden |
| | | buñga de China | *Adonidia merrillii* (Becc.) Becc. |
| | | carnation | *Dianthus* sp. |
| | | larkspur | *Delphinium* spp. |
| | | petunia | *Petunia* sp. |
| | | buglelily | *Watsonia* sp. |
| Fajardo (13) | 1934 | potato | *Solanum tuberosum* Linn. |
| Reyes (36) | 1934 | banana | *Musa sapientum* var. *cinerea* (Blanco) Teodoro |
| | | buñga ñg tubo | *Aeginetia indica* Linn. |
| | | eggplant | *Solanum melongena* Linn. |
| | | everlasting | *Helichrysum bracteatum* Willd. |
| | | wheat | *Triticum vulgare* Vill. |
| Celino (10) | 1936 | abacá | *Musa textilis* Née. |
| | | cacao | *Theobroma cacao* Linn. |
| | | corn | *Zea mays* Linn. |
| | | cotton | *Gossypium* sp. |
| | | cutcharitas | *Alternanthera versicolor* Hort. |
| | | dasheen | *Colocasia* sp. |
| | | ikmo or buyo | *Piper betle* Linn. |
| | | indigo | *Indigofera hendecaphylla* Jacq. |
| | | lettuce | *Lactuca sativa* Linn. |
| | | jackfruit | *Artocarpus integra* (Thumb ) Merr. |
| | | ---------- | *Christisonia* sp. |

[a] Cited by Celino (10).

listed, it was observed on pink zephyrlily (*Atamosco rosea* [Lindl.] Greene), generally used for border planting, scarlet sage (*Salvia splendens* Ker-Gawl),[12] cassava (*Manihot utilissima* Pohl.), cowpea (*Vigna sinensis* [Linn.] Savi), and on a ground orchid, locally known in Tagalog as "tabu-dapi" (*Spathoglottis plicata* Blume). Mr. M. A. Palo of the Plant Pathology Laboratory, Bureau of Plant Industry, has recently determined the occurrence of *S. rolfsii* on mango (*Mangifera indica* Linn.) and upo (*Lagenaria leucantha* [Duch.] Rusby). Isolations made from these host plants revealed distinct characters and growth habits which cannot be mistaken for *S. rolfsii.*

Other plants which are attacked by the fungus in artificial inoculation were reported by Ramos(33) who found among others, the following to be highly susceptible to *S. rolfsii* attack: casubha (*Carthamus tinctorius* Linn.), cockscomb (*Celosia cristata* Linn.), mustard (*Brassica integrifolia* [West] O. E. Schulz), okra (*Abelmoschus esculentus* [Linn.] Moench.), papaya (*Carica papaya* Linn.), pea (*Pisum sativum* Linn.), pechay (*Brassica cernua* [Thumb.] Forbes and Hemsl.), patani (*Phaseolus lunatus* Linn.), sincamas (*Pachyrrhizus erosus* Linn.) Urban, *Stenolobium stans* (Linn.) D. Don. and *Crotalaria anagyroides* HBK. Palo(30) also produced disease by inoculation with *S. rolfsii* on seedlings of the following plants: ampalaya or amargoso (*Momordica charantia* Linn.), cabbage (*Brassica oleracea* Linn, var. *capitata* Linn.), radish (*Raphanus sativus* Linn.), and other plants used previously by Ramos(33). Investigators in other countries as Ceylon, India (Bertus, 6) reported it to infect artificially many different kinds of plants, especially at the seedling stage. It also causes considerable damage to stored products, such as cassava and sweet potato in the Philippines, and cabbage, Irish potato, pumpkins, squash and sweet potato as reported by Taubenhaus(43) in the United States.

Rolfs(39) of the Florida Agricultural Experiment Station reported its occurrence on beans, cowpeas, eggplant, squash, cabbage, beets and melons among the garden plants; hydrangeas and daphnes among ornamentals; and also on young fig trees and weeds. Taubenhaus(43) compiled its incidence on 32 different hosts in the United States, particularly in the southern part, where the disease is prevalent. Stevens(42) reported its occurrence on 28 or more plants in central and southern United

[12] Host identifications by Mr. E. Karganilla of the National Museum, Bureau of Science, Manila, P. I.

States. Palm and Fulmek(28) listed in Sumatra 21 economic crops, 4 green manures, 6 ornamentals, and 7 weeds as host plants of *S. rolfsii*. In the same year Birmingham(8) of New South Wales also reported its occurrence on 30 different hosts, comprising economic crops, ornamentals and weeds. According to Paintin(26), *Sclerotium rolfsii* is parasitic on about 140 plant species, including major crops. This author also states that the increasing damage due to it makes the problem of control a serious one, especially in the southeastern United States. The latest available report by Weber(46) gives a list of 189 plants found mostly in the United States and other countries. Many of these plants are cultivated in the Philippines.

The importance of enumerating the wide variety of plants, especially crop plants, which are subject to the attack of this pathogenic fungus in the Philippines under natural or artificial conditions of exposures, is to apprize the farmers of the hazards of adapting any ill-advised order of rotation.

### TESTS FOR VARIETAL RESISTANCE

As it is humanly impossible to secure a piece of ground in which the soil is absolutely uniform, a method of planting was devised whereby the varieties employed were arranged as shown in Fig. 1. There are also other advantages which accrue from this arrangement, instead of planting the varieties in adjoining or contiguous plats. If more space had been available to increase the number of check plats the differences in soil conditions could have been further reduced.

### METHOD OF PLANTING, CARE, AND HARVESTING

The varieties used in disease-resistance experiments were raised by Mr. Unite of the Bureau of Plant Industry. Sound seeds of the same age were used in order to insure uniformity of growth as much as possible in both check and inoculated plats. In subsequent cultures, the seeds were selected from control plants.

The land used for the tests was never planted to peanuts before. It was prepared with the same implements and in the same manner throughout. Plowing was done both ways twice and then it was harrowed after each plowing.

The experimental field was quite level. It was divided into rectangular plats (Plate 7) as shown in the planting plan in Fig. 1. The field was chosen for apparent uniformity of the soil and plats 1 $\times$ 5 meters in size with a path between each

of 65 centimeters wide from side to side and 50 centimeters from end to end. The paths served to preclude interlocking of plants of two different varieties. They also served for drainage, during rainy weather. The planting of the twelve varieties was so arranged that each variety was separated from the adjacent varieties by a dead space, and each variety occurred in one replication of a series. To provide loose earth for the development of the pods the plats were raised about 10 centimeters high. In all cultures the seeds sown were selected for maturity and purity. Plantings were done uniformly by placing three kernels in each hill, except the last one, at a depth of approximately 5 centimeters. The rows were 40 centimeters apart[13] and the hills were 30 centimeters apart in the row. Seasonal plantings were all done in one day.

Both the plats for inoculation and for control received the same treatment in regard to cultivation, weeding and watering. Only occasional watering was done, however. With the exception of the last test, the first two trials were conducted in the same plats.

At maturity, or after the lapse of four months, harvesting was done with spading forks. The plants were gathered and placed in separate paper bags. After examinations and counts were made, the pods were harvested and dried in the sun at equal lengths of time. The harvesting of inoculated and control plats of each variety was done on the same date.

### TECHNIC OF INOCULATION

All the inoculation tests were conducted a month and a half after planting. The isolate selected for all inoculation work was obtained from Valencia, a variety which was most susceptible. The use of the fungus from Valencia was made on the supposition that it is probably more virulent than those isolated from the other varieties.

Small thin blocks of uniform size, about 8 millimeters square, were cut with a sharp, flamed scalpel from cultures on plated potato-glucose agar of four to five days of age. With the aid of sterile forceps, a block containing vigorously-growing hyphae was placed on the uninjured base of the plant touching the ground level on every hill. With this procedure approximately 1,200 blocks were required to complete the series of

[13] Wider space, or 60 to 75 centimeters apart between rows, is permissible in commercial plantings in order to admit satisfactory cultivation.

yearly inoculations. All efforts were made in each of the three seasons to accomplish inoculations in one day for uniformity.

The control plats (Plates 9 and 11) were treated exactly the same as the inoculated plats except that no fungus was used. Under extremely unfavorable conditions watering of the inoculated plats was done to start the growth of the fungus. Occasional weeding was done by picking or uprooting them with the aid of a piece of flattened iron bar with a dull edge. A disease similar to that produce in nature was produced by these inoculations. Except in doubtful cases, reisolations were not found very necessary.

### METHOD OF GATHERING DATA AND EVALUATING RESISTANCE

At each season observations were made and notes were kept of the date of infections, the number of wilted plants, and finally the number of plants that died and those that survived. Infection was judged by the symptoms and signs of the disease.

The percentage of plants which survived the effects of inoculations was used as an index of resistance. At harvest time, plant counts of each variety were made to determine the percentages of infection. In this work the number of plants that escaped the disease and those that were infected were counted. To secure a comparison of the relative susceptibility of the varieties, the number of diseased pods as well as the number of marketable pods and their corresponding weights were recorded. Counts of germinated pods were also made. To reduce

TABLE 6.—*Results of artificial infection experiment with Sclerotium rolfsii conducted in 1934*

| Variety | Initial stand | | Number of plants infected [a] | | Per cent infection | |
|---|---|---|---|---|---|---|
| | Control | Inoculated | Control | Inoculated | Control | Inoculated |
| Biit | 39 | 52 | 0 | 26 | 0 | 50.00 |
| Cagayan No. 1 | 51 | 52 | 0 | 26 | 0 | 50.00 |
| Georgia Red | 64 | 62 | 0 | 36 | 0 | 58.06 |
| Macapno | 48 | 64 | 0 | 33 | 0 | 51.56 |
| San José No. 3 | 65 | 43 | 0 | 25 | 0 | 58.13 |
| Spanish | 42 | 51 | 0 | 24 | 0 | 47.06 |
| Tirik | 45 | 58 | 0 | 13 | 0 | 22.41 |
| Valencia | 51 | 43 | 0 | 35 | 0 | 81.39 |
| Vigan Lupog | 64 | 67 | 0 | 22 | 0 | 32.83 |
| Virginia Jumbo | 31 | 19 | 0 | 0 | 0 | 0 |
| Virginia Jumbo (a) | 33 | 38 | 0 | 1 | 0 | 2.63 |
| White Improved Spanish | 53 | 44 | 0 | 23 | 0 | 52.27 |

[a] Symptoms suspicious of presence of other organisms were isolated in case of doubts.

errors due to loss of moisture, weighings were always made on the same date.

EXPERIMENTAL RESULTS

*Field experiment in 1934.*—On April 12, 1934 an experiment was conducted to study the relative resistance of peanut varieties to Sclerotium wilt, by inoculation under field conditions. The results of this inoculation are given in Tables 6 and 7. The comparative susceptibility of the twelve varieties used and the effect of infection on the yield of pods are indicated in these tables.

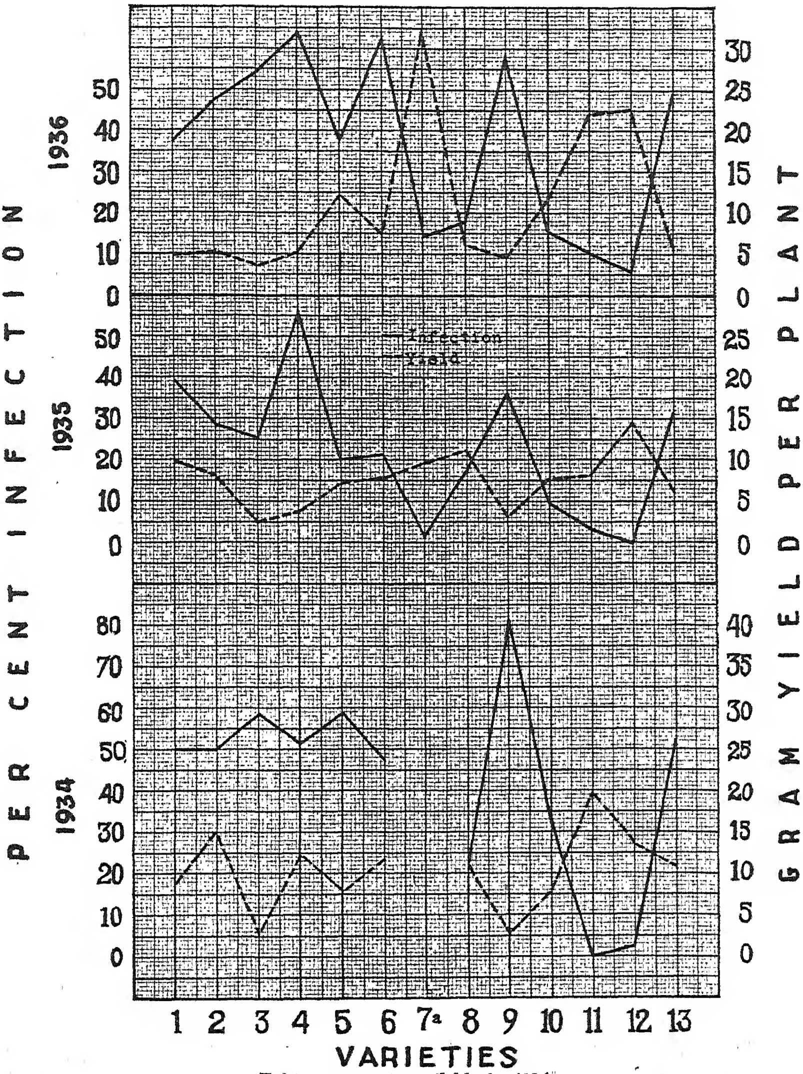
Tables 6 and 7, show the results of a preliminary trial on the relative resistance and yields of different varieties of peanuts.

TABLE 7.—*Showing the yield in pods per plant, and counts of diseased and germinated pods, based on actual number of plants used in 1934*

| Variety | Number of plants | | Yield in pods (marketable) | |
|---|---|---|---|---|
| | Control | Inoculated | Control | Inoculated |
| | | | *Grams* | *Grams* |
| Biit | 39 | 52 | 615.5 | 460.5 |
| Cagayan No 1 | 51 | 52 | 779.2 | 781.5 |
| Georgia Red | 64 | 62 | 226.0 | 164.9 |
| Macapno | 48 | 64 | 801.5 | 797.0 |
| San José No. 3 | 65 | 43 | 582.0 | 342.0 |
| Spanish | 42 | 51 | 736.2 | 611.5 |
| Tirik | 45 | 58 | 473.5 | 642.5 |
| Valencia | 51 | 43 | 233.5 | 116.5 |
| Vigan Lupog | 64 | 67 | 460.0 | 519.0 |
| Virginia Jumbo | 31 | 19 | 517.7 | 379.4 |
| Virginia Jumbo (a) | 33 | 38 | 513.9 | 524.0 |
| White Improved Spanish | 53 | 44 | 743.2 | 483.5 |

| Variety | Yield per plant (marketable) | | Number of diseased pods | | Number of germinated pods | |
|---|---|---|---|---|---|---|
| | Control | Inoculated | Control | Inoculated | Control | Inoculated |
| | *Grams* | *Grams* | | | | |
| Biit | 15.77 | 8.85 | 0 | 66 | 52 | 41 |
| Cagayan No. 1 | 15.27 | 15.02 | 0 | 42 | 9 | 11 |
| Georgia Red | 3.53 | 2.65 | 0 | 133 | 50 | 54 |
| Macapno | 16.69 | 12.45 | 0 | 78 | 7 | 20 |
| San José No. 3 | 8.95 | 7.93 | 0 | 33 | 32 | 39 |
| Spanish | 17.52 | 11 99 | 0 | 89 | 11 | 46 |
| Tirik | 10.52 | 11.07 | 0 | 43 | 85 | 83 |
| Valencia | 4.57 | 2.70 | 0 | 222 | 97 | 54 |
| Vigan Lupog | 7.18 | 7.74 | 0 | 38 | 37 | 21 |
| Virginia Jumbo | 16.70 | 19.96 | 0 | 0 | 0 | 0 |
| Virginia Jumbo (a) | 15.57 | 13.78 | 0 | 0 | 0 | 0 |
| White Improved Spanish | 14.02 | 10.98 | 0 | 49 | 42 | 13 |

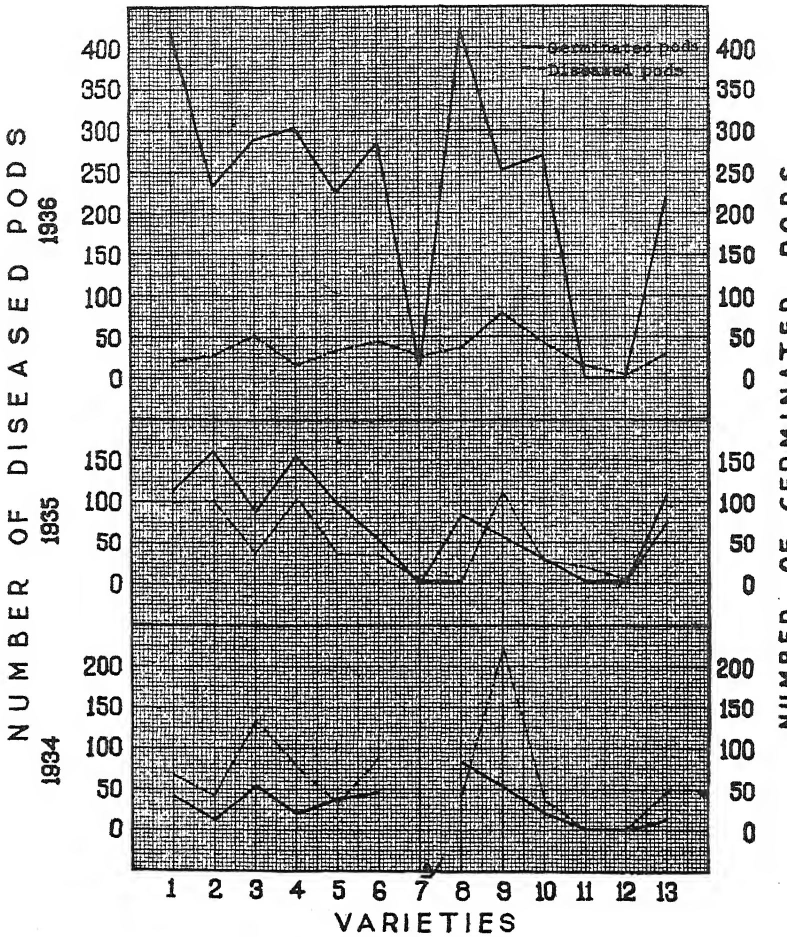
The results (Graph shown in Fig. 2) show striking differences in susceptibility to infection. In the case of very susceptible varieties it was easy to obtain a large number of infection, in progression, although it required a long time. The same symptoms (Plates 8, 10 and 12) as those observed in the field were produced on the inoculated plants and the fungus was readily reisolated. The control plats (Plates 9 and 11) remained




[a] Tai-tau was not available in 1934.

FIG. 2. Representing graphically the effect of artificial inoculation on the yield for the three-year period.

healthy. Under the conditions of the experiment, the varieties, in order of their susceptibility were as follows: Valencia, Georgia Red, San José No. 3, White Improved Spanish, and Macapno. These varieties showed exceedingly high percentages of in-




ᵃ Tai-tau was not available in 1934.

FIG. 3. Chart showing by year the effect of inoculation on the pods underground.

fection, while Biit, Cagayan No. 1, and Spanish suffered less injuries. Those moderately resistant were Tirik and Vigan Lupog, while Virginia Jumbo(a) and Virginia Jumbo showed notable resistance. The freedom from infection of the last variety, however, may be attributed to fewer number of plants

inoculated or to paucity of inoculum. The virulent behavior of the disease in general seemed to have been enhanced by the acid condition of the soil, the peanut plats varying in hydrogen-ion concentration from pH 5.33 to pH 5.83, and the fungus being an acid-loving organism. Virginia Jumbo (a) is a strain selection which has been in cultivation here for some time, while Virginia Jumbo is of recent introduction. Considerable reduction of yield of nuts resulted from inoculation, except in the three varieties, Tirik, Vigan Lupog and Virginia Jumbo. The number of diseased pods were greater in susceptible varieties than in those affected to a less degree as shown in Fig. 3. In this year's experiment it was noted that the presence of disease accelerated somewhat the germination of pods underground.

*Field experiment in 1935.*—The second inoculation experiment was conducted during the latter part of 1935, under somewhat disimilar conditions. The same varieties that were planted in 1934 and a Chinese variety, Tai-tau (Plate 16), were grown in the same field used in 1934. The same methods of planting were followed. Inoculations were made on October 7, 1935. In this experiment, precautions were taken in preparing the land so as not to scatter infection from the inoculated plats. The infested plats were again used for the plants to be inoculated. The results of this experiment are given in Tables 8 and 9.

TABLE 8.—*Results of artificial infection experiment with Sclerotium rolfsii conducted in 1935*

| Variety | Initial stand | | Number of plants infected | | Per cent infection | |
|---|---|---|---|---|---|---|
| | Control | Inoculated | Control[a] | Inoculated | Control | Inoculated |
| Biit | 95 | 84 | 1 | 33 | 1.05 | 39.28 |
| Cagayan No. 1 | 94 | 91 | 0 | 26 | 0 | 28.57 |
| Georgia Red | 69 | 91 | 2[b] | 23 | 2.89 | 25.27 |
| Macapno | 86 | 90 | 0 | 51 | 0 | 56.66 |
| San José No. 3 | 47 | 45 | 1 | 9 | 2.12 | 20.00 |
| Spanish | 93 | 79 | 0 | 17 | 0 | 21.51 |
| Tai-tau | 78 | 86 | 0 | 1 | 0 | 1.16 |
| Tirik | 91 | 93 | 0 | 16 | 0 | 17.20 |
| Valencia | 97 | 83 | 1 | 30 | 1.03 | 36.14 |
| Vigan Lupog | 90 | 95 | 0 | 9 | 0 | 9.47 |
| Virginia Jumbo | 96 | 95 | 0 | 3 | 0 | 3.15 |
| Virginia Jumbo (a) | 89 | 83 | 0 | 0 | 0 | 0 |
| White Improved Spanish | 85 | 87 | 1 | 26 | 1.17 | 31.03 |

[a] Contaminations believed to have taken place either through mechanical means or naturally.

[b] One plant was infected on lateral stem.

TABLE 9.—*Showing the yield in pods, per plant, and counts of diseased and germinated pods, based on actual number of plants used in 1935*

| Variety | Number of plants | | Yield in pods (marke able) | |
|---|---|---|---|---|
| | Control | Inoculated | Control | Inoculated |
| | | | *Grams* | *Grams* |
| Biit | 95 | 84 | 1,165.5 | 831.5 |
| Cagayan No. 1 | 94 | 91 | 962.0 | 748.7 |
| Georgia Red | 69 | 91 | 224.5 | 228.0 |
| Macapno | 86 | 90 | 735.8 | 354.5 |
| San José No. 3 | 47 | 45 | 230.5 | 334.7 |
| Spanish | 93 | 79 | 851.5 | 628.0 |
| Tai-tau | 78 | 86 | 654.0 | 841.5 |
| Tirik | 91 | 93 | 1,267.5 | 1,039.7 |
| Valencia | 97 | 83 | 440.0 | 259.5 |
| Vigan Lupog | 90 | 95 | 725.5 | 738.5 |
| Virginia Jumbo | 96 | 95 | 943.5 | 773.0 |
| Virginia Jumbo (a) | 89 | 83 | 1,290.0 | 1,224.0 |
| White Improved Spanish | 85 | 87 | 728.0 | 534.5 |

| Variety | Yield per plant (marketable) | | Number of diseased pods | | Number of germinated pods | |
|---|---|---|---|---|---|---|
| | Control | Inoculated | Control | Inoculated | Control | Inoculated |
| | *Grams* | *Grams* | | | | |
| Biit | 12.26 | 9.89 | 7 | 99 | 26 | 114 |
| Cagayan No. 1 | 10.23 | 8.22 | 0 | 101 | 22 | 162 |
| Georgia Red | 3.25 | 2.50 | 11 | 38 | 55 | 87 |
| Macapno | 8.55 | 3.93 | 0 | 105 | 29 | 157 |
| San José No. 3 | 4.90 | 7.43 | 9 | 37 | 16 | 98 |
| Spanish | 9.15 | 7.94 | 0 | 35 | 36 | 54 |
| Tai-tau | 8.38 | 9.78 | 0 | 5 | 2 | 1 |
| Tirik | 13.92 | 11.17 | 0 | 4 | 34 | 84 |
| Valencia | 4.53 | 3.12 | 7 | 113 | 182 | 58 |
| Vigan Lupog | 8.06 | 7.77 | 0 | 28 | 51 | 30 |
| Virginia Jumbo | 9.82 | 8.13 | 0 | 22 | 2 | 4 |
| Virginia Jumbo (a) | 14.49 | 14.74 | 0 | 5 | 0 | 3 |
| White Improved Spanish | 8.56 | 6.14 | 4 | 77 | 27 | 109 |

The results of inoculation experiments in 1935 resemble somewhat in general those obtained in 1934 as to the response of the varieties. There was noted, however, an almost wholesale decrease in the percentages of infected plants which may be attributed partly to the liberal application of hydrated lime, at the rate of 500 kilograms per hectare, applied two months ahead of sowing time. With the exception of Virginia Jumbo (a) all varieties displayed varying degrees of infection. Tai-tau and Virginia Jumbo were the least affected varieties (Fig. 2). These were followed by Vigan Lupog and Tirik (Plate 14). The varieties greatly affected by inoculation were Macapno,

Biit, Valencia and White Improved Spanish, while the others fell in between the two classes. One plant of Georgia Red (check) which was infected on the lateral stem was probably inoculated through mechanical means. A conspicuous decrease in yield was noted in inoculated plats of ten varieties; the susceptible varieties suffered greater damage than the less susceptible ones. As regards diseased and germinated pods (Fig. 3), the figures obtained are in general agreement with those of the experiment in 1934.

*Field experiment in 1936.*—Field inoculations in the wet season of 1936 were made on September 21, 1936, following essentially the same general plan. Due to some unavoidable circumstances, a new field was opened and made available for the 1936 inoculation experiment. Tables 10 and 11 give the results obtained in 1936.

TABLE 10.—*Results of artificial infection experiment with Sclerotium rolfsii conducted in 1936*

| Variety | Initial stand | | Number of plants infected | | Per cent infection | |
|---|---|---|---|---|---|---|
| | Control | Inoculated | Control[a] | Inoculated | Control | Inoculated |
| Biit | 95 | 94 | 0 | 35 | 0 | 37.23 |
| Cagayan No. 1 | 99 | 84 | 1 | 40 | 1.01 | 47.61 |
| Georgia Red | 87 | 70 | 0 | 38 | 0 | 54.28 |
| Macapno | 98 | 75 | 3 | 48 | 3.06 | 64.00 |
| San José No. 3 | 61 | 82 | 0 | 31 | 0 | 37.80 |
| Spanish | 83 | 89 | 0 | 56 | 0 | 62.92 |
| Tai-tau | 77 | 85 | 0 | 12 | 0 | 14.11 |
| Tirik | 85 | 99 | 0 | 17 | 0 | 17.94 |
| Valencia | 95 | 90 | 2[b] | 53 | 2.10 | 58.88 |
| Vigan Lupog | 84 | 78 | 2 | 12 | 2.38 | 15.38 |
| Virginia Jumbo | 47 | 59 | 0 | 6 | 0 | 10.16 |
| Virginia Jumbo (a) | 89 | 88 | 0 | 5 | 0 | 5.68 |
| White Improved Spanish | 74 | 87 | 1[c] | 43 | 1.35 | 49.42 |

[a] Contaminations believed to have taken place either through mechanical means or naturally.
[b] and [c] Infection took place on lateral stems touching the ground and not at the base.

Owing perhaps to more favorable conditions prevalent during this year's test, all varieties suffered infections in varying degrees. On the whole, however, the order of susceptibility (Fig. 2) approaches somewhat that of 1934 and more closely that of 1935. The results showed the relative resistance of the different varieties to *Sclerotium rolfsii*. More or less consistent results were obtained in the three trials.

A marked reduction of yield of pods resulted from inoculation although this year's production both in pods (Table 11) and in

straw, exceeded the previous tests. The weather and soil conditions evidently favored the germination of more pods (Fig. 3). Although a smaller number of diseased pods was observed this year all varieties yielded diseased pods (Plates 21 and 22). The runner varieties yielded more hay than the erect or semi-erect types, especially during this season. The infection of plants in this type was usually partial (Plates 18, 19 and 20) as in Virginia Jumbo and Tai-tau.

TABLE 11.—*Showing the yield in pods per plant, and counts of diseased and germinated pods, based on actual number of plants used in 1936*

| Variety | Number of plants | | Yield in pods (marketable) | |
|---|---|---|---|---|
| | Control | Inoculated | Control | Inoculated |
| | | | *Grams* | *Grams* |
| Biit | 95 | 94 | 1,200.3 | 465.0 |
| Cagayan No. 1 | 99 | 84 | 1,040.4 | 448.5 |
| Georgia Red | 87 | 70 | 938.4 | 257.0 |
| Macapno | 98 | 75 | 717.5 | 395.8 |
| San José No. 3 | 61 | 82 | 1,339.8 | 993.8 |
| Spanish | 83 | 89 | 757.0 | 663.8 |
| Tai-tau | 77 | 85 | 2,705.6 | 2,754.1 |
| Tirik | 85 | 99 | 1,093.3 | 610.0 |
| Valencia | 95 | 90 | 934.0 | 407.0 |
| Vigan Lupog | 84 | 78 | 1,553.4 | 911.5 |
| Virginia Jumbo | 47 | 59 | 1,362.5 | 1,307.0 |
| Virginia Jumbo (a) | 89 | 88 | 2,350.6 | 1,999.5 |
| White Improved Spanish | 74 | 87 | 613.0 | 510.5 |

| Variety | Yield per plant (marketable) | | Number of diseased pods | | Number of germinated pods | |
|---|---|---|---|---|---|---|
| | Control | Inoculated | Control | Inoculated | Control | Inoculated |
| | *Grams* | *Grams* | | | | |
| Biit | 12.63 | 4.94 | 0 | 19 | 142 | 422 |
| Cagayan No. 1 | 10.50 | 5.33 | 10 | 22 | 94 | 233 |
| Georgia Red | 10.78 | 3.67 | 0 | 51 | 226 | 289 |
| Macapno | 7.32 | 5.27 | 0 | 16 | 114 | 304 |
| San José No. 3 | 21.96 | 12.11 | 0 | 34 | 147 | 225 |
| Spanish | 9.12 | 7.45 | 0 | 44 | 234 | 286 |
| Tai-tau | 35.13 | 32.40 | 0 | 26 | 0 | 14 |
| Tirik | 12.86 | 6.16 | 0 | 36 | 240 | 424 |
| Valencia | 9.83 | 4.52 | 9 | 79 | 121 | 252 |
| Vigan Lupog | 18.49 | 11.69 | 2 | 43 | 153 | 270 |
| Virginia Jumbo | 28.98 | 22.15 | 0 | 15 | 6 | 0 |
| Virginia Jumbo (a) | 26.41 | 22.72 | 0 | 4 | 0 | 0 |
| White Improved Spanish | 8.28 | 5.86 | 3 | 30 | 236 | 219 |

The results of the three year's experiments are summarized in Tables 12 and 13. According to the results, the percentages of infection varied according to seasonal conditions. This was evi-

dent in the 1936 plat experiment when the intermittent rain and sunshine was followed by more infection than in the preceding years.

TABLE 12.—*Summary of percentages of infection, yield per plant, and reduction in yield due to infection obtained from the three trials (1934, 1935 and 1936)*

| Variety | Average infection | Rank of susceptibility | Average yield per plant | | Difference | Reduction in yield |
|---|---|---|---|---|---|---|
| | | | Control | Inoculated | | |
| | *Per cent* | | *Grams* | *Grams* | *Grams* | *Per cent* |
| Biit | 42.17 | 6 | 13.55 | 7.89 | 5.66 | 41.77 |
| Cagayan No. 1 | 42.06 | 7 | 12.00 | 8.85 | 3.15 | 26.25 |
| Georgia Red | 45.87 | 3 | 5.85 | 2.94 | 2.91 | 49.74 |
| Macapno | 57.40 | 2 | 10.85 | 7.21 | 3.64 | 33.54 |
| San José No. 3 | 38.64 | 8 | 11.93 | 9.12 | 2.81 | 23.55 |
| Spanish | 43.83 | 5 | 11.93 | 9.12 | 0.48 | 5.00 |
| Tai-tau [a] | 7.63 | 11 | 14.50 | 14.06 | 0.44 | 3.03 |
| Tirik | 19.18 | 10 | 12.43 | 9.46 | 2.97 | 23.89 |
| Valencia | 58.80 | 1 | 6.31 | 3.44 | 2.87 | 45.48 |
| Vigan Lupog | 19.22 | 9 | 11.24 | 9.06 | 2.18 | 19.39 |
| Virginia Jumbo | 4.43 | 12 | 18.50 | 16.74 | 1.76 | 9.51 |
| Virginia Jumbo (a) | 2.77 | 13 | 18.82 | 17.09 | 1.73 | 9.19 |
| White Improved Spanish | 44.24 | 4 | 10.28 | 7.66 | 2.59 | 25.19 |

[a] Not available in 1934.

Table 12, showing a three-year summary, gives the average percentage of infection obtained through inoculation of the varieties used. The results are graphically represented in Fig. 4. The destructive effect on nut yield was very substantial. The experiments show conclusively the relative resistance of the varieties of peanuts to *S. rolfsii* infection. The relative response of the different varieties to artificial inoculations during the three-year period was quite consistent. The varieties of peanut arranged in descending order of their susceptibility to infection are as follows: (1) Valencia, (2) Macapno, (3) Georgia Red, (4) White Improved Spanish, (5) Spanish, (6) Biit, (7) Cagayan No. 1, (8) San José No. 3, (9) Vigan Lupog, (10) Tirik, (11) Tai-tau, (12) Virginia Jumbo and (13) Virginia Jumbo (a).

The chart shown in Fig. 5, shows some relation to infection of the number of diseased pods and the number of germinated pods in inoculated plants or varieties. In 1934 the average number of germinated pods was slightly less than in the control varieties (Table 7). In the next two year's experiments, however, the number of germinated pods in the inoculated varieties

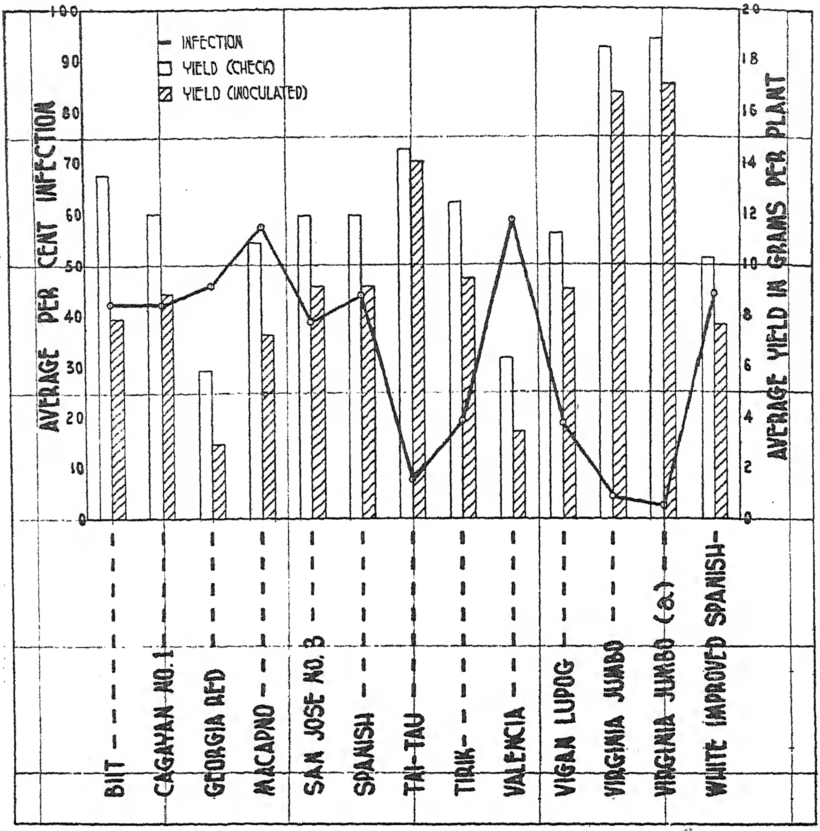



FIG. 4. Chart showing the effect of *Sclerotium rolfsii* infection on the yield, based on three years experiments.

was greater than those of the check plants (Tables 9 and 11). There was an average difference of about 36 pods in 1935, and about 94 pods in 1936. The weakening of the pegs of diseased pods seemed to be closely associated with the number of infected pods, as are also the decrease in weight of the pods, and the disintegration of their shells. A corresponding increase in the number of pods was observed in both the control and the inoculated plants during the wet season of 1936. A very wet soil, however, did not favor the development underground of *S. rolfsii* as shown by the third year's result (Table 11).

The consistent and more or less uniform results obtained in the field experiments indicate conclusively the relative resistance of the varieties of peanuts to the disease. The commercial

varieties of peanuts used, the average percentages of infection, and their relations to *Sclerotium rolfsii* are given in Table 14.

TABLE 13.—*Relative damage caused by Sclerotium rolfsii on peanut varieties as indicated by the number of diseased pods and germinated pods obtained in the 1934, 1935 and 1936 tests*

| Variety | 1934, 1935 and 1936 | | | |
|---|---|---|---|---|
| | Average number of diseased pods | | Average number of germinated pods | |
| | Control | Inoculated | Control | Inoculated |
| Biit | 2.33 | 61.33 | 73.33 | 192.33 |
| Cagayan No. 1 | 3.33 | 55.00 | 41.66 | 135.33 |
| Georgia Red | 3.66 | 74.00 | 10.33 | 143.33 |
| Macapno | 0 | 66.33 | 50.00 | 160.33 |
| San José No. 3 | 3.00 | 34.66 | 65.00 | 120.66 |
| Spanish | 0 | 56.00 | 93.66 | 128.66 |
| Tai-tau [a] | 0 | 10.33 | 00.66 | 5.00 |
| Tirik | 0 | 27.66 | 119.66 | 197.00 |
| Valencia | 5.33 | 138.00 | 133.33 | 121.33 |
| Vigan Lupog | 0.66 | 36.33 | 80.33 | 107.33 |
| Virginia Jumbo | 0 | 12.33 | 266.00 | 1.33 |
| Virginia Jumbo (a) | 0 | 3.00 | 0 | 1.00 |
| White Improved Spanish | 2.33 | 52.00 | 101.66 | 113.66 |

[a] Two years only.

TABLE 14.—*Relative response of peanut varieties to artificial inoculation with Sclerotium rolfsii*

| Classes | Proposed ratings of infection | Varieties and order of susceptibility according to percentages of infection |
|---|---|---|
| Very susceptible | 83.31–100% | |
| Susceptible | 66.65–83.30% | |
| Moderately susceptible | 49.99–66.64% | Valencia, Macapno. |
| Resistant | 33.33–49.98% | Georgia Red, White Improved Spanish, Spanish, Biit, Cagayan No. 1, San José No. 3. |
| Moderately resistant | 16.67–33.32% | Vigan Lupog, Tirik. |
| Highly resistant | 1.00–16.66% | Tai-tau, Virginia Jumbo, Virginia Jumbo (a). |
| Immune | 0% | |

In Table 14 it may be seen that of the varieties inoculated in the field, not a single variety was immune, although Virginia Jumbo(a) exhibited only a trace of infection. According to the proposed ratings of infection, Tai-tau, Virginia Jumbo, and Virginia Jumbo(a), are in the highly resistant class while Valencia and Macapno fall under the opposite extreme as moderately susceptible, and so on.

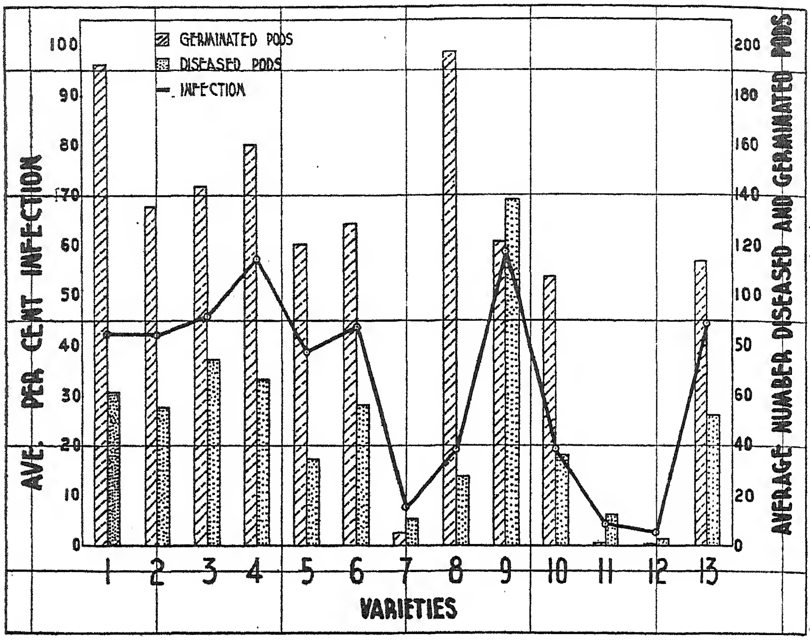



FIG. 5. Chart showing the relation of the number of infected plants to the number of diseased and germinated pods, based on three years' experiments.

## DISCUSSION OF RESULTS

The Sclerotium wilt of peanut may be recognized by the wilting of the plant and the presence of lesions and mycelium on the stem. The symptoms are more pronounced under environmental conditions which promote least resistance to many plant diseases. Abundant soil moisture, high temperature and air humidity, as well as young age of plant are factors influencing the development of the disease. This influence of environment on disease was manifest by the frequent occurrence of infection in restricted areas where the plants were exposed to the same conditions. Absence of moisture has a detrimental effect upon the growth of the fungus.

The consistently uniform results in field experiments indicate conclusively the relative response of the varieties to the disease. Of the varieties inoculated in the field, not a single one was immune (Table 14), although Virginia Jumbo (a) was the most highly resistant to the disease. This variety showed only a trace of infection (Tables 6, 8 and 10). Immediately after Virginia Jumbo (a) follow Virginia Jumbo and Tai-tau. These varieties belong to the highly resistant class. Although Valen-

cia had 81.38 per cent infection in 1934 (Plate 13), the average percentage of infection was lower in subsequent years. Valencia and Macapno proved to be moderately susceptible varieties, while Tirik (Plate 14) and Vigan Lupog were moderately resistant. Georgia Red, White Improved Spanish, Spanish, Biit, Cagayan No. 1 and San José No. 3 are here classified as intermediates.

The different types of varietal response to disease development does not seem to have any relation to the habit of growth. While the prostrate varieties which are in close contact with the soil and soil organism may be expected to be more liable to infection, the erect or decumbent varieties proved less resistant to *Sclerotium* attack. Evidently the question of resistance of peanut to Sclerotium wilt has no relation to the habit of growth. Mohammad *et al.*(24) propound the idea that the spreading varieties revealed stronger capacity for disease resistance than the erect varieties. Field observations seem to indicate that relative succulence is also a determining factor for resistance (Plate 18).

It is interesting to note that despite the prostrate nature and luxuriance of vegetative growth of Virginia Jumbo (Plates 15 and 17) and Tai-tau (Plate 16), affording their runners greater chances for infection through the soil, these spreading varieties were less infected by the disease, and occasionally they were only partially (Plates 15, 16 and 17) attacked. This finding confirms the field observations of McClintock(22). Just what the nature of resistance is cannot be explained at present.

Tai-tau and Virginia Jumbo are two peanut varieties of the runner type. These varieties possess the qualities desired by farmers, dealers and consumers. Although these exotic varieties are late-maturing, they possess the rare combination of marked resistance to Sclerotium wilt together with the seed dormancy, large seeds, dark green foliage, and high yielding capacity. The value of these varieties is enhanced further by the fact that they also revealed considerable resistance to black spot infection caused by *Cercospora personata* (B. & C.) Ell. & Ev., a very common disease although of less economic importance than Sclerotium wilt.

It will be readily seen by referring to Table 13 that the resistant varieties which are generally late-maturing suffered lesser amount of damage either through infection of the fruits or through germination underground, presumably on account of thickness of the pericarp as compared with those which mature early.

There are two strains of Virginia Jumbo. One is of recent introduction, and the other, marked Virginia Jumbo(a), is a strain which has been grown for a number of years at the experiment stations of the Bureau of Plant Industry. The two plants from separate introductions react differently and in a manner somewhat consistently to *Sclerotium rolfsii* perhaps because Virginia Jumbo(a) (Plate 15) had been exposed to infection for a much longer period under Philippine conditions than the other strain; hence it may be said that it has acquired a certain degree of resistance.

Virginia Jumbo (Plate 17), a comparatively new variety in the Philippines seems to be the most resistant under field conditions when grown side by side with other varieties. It is also desirable because it is a heavy yielder on lands previously used for other crops and where other varieties grown side by side with it have failed to produce satisfactorily. The writer's results thus far show that the danger from Sclerotium wilt may still be remedied by growing resistant varieties. The results of present experiments show what varieties of peanuts to plant in *Sclerotium rolfsii*-infested soil. Virginia Jumbo and Tai-tau have invariably displayed conspicuous resistance against the ravages of this fungus.

The more or less consistent reaction of these two varieties to inoculation indicates that they carry a certain degree of inherent resistance. Working on this hypothesis, the genetic factors for breeding of varieties would seem well-nigh clear and in order. Since no variety possesses a combination of all the desirable crop factors, hybridization followed by selection would seem the best solution.

## OTHER MEASURES OF CONTROL

All infected plants should be pulled out as soon as noticed. They should be destroyed by drying in the sun or by burning to prevent the propagation of the disease.

As recommended by Bertus(6) in Ceylon the soil surface of infected areas (to a depth of 8 inches or more) should be scraped off and buried in trenches or dug-outs made nearby in order to bury sclerotia that are present in the surface soil to a depth of 9 to 12 inches.

Avoid scattering diseased plants and handle them carefully because the adhering sclerotia are readily shattered.

Diseased plants should be burned *in situ* after the nuts have been harvested; then the surface soil should be forked or raked over to break the continuity of the hyphal strands. All dead leaves and decaying matter should be piled up and burned.

Close planting should be avoided, because contact of diseased and healthy plants facilitates the spread of the disease from one hill to another. Sunlight and aëration are effective checks against the progress of the fungus.

The fungus may also be spread through the soil by the migration of the fungus, by infested soils, sclerotia or diseased materials transported by water from one place to another, cultivating implements, on the feet of men and animals, and other agencies. Cattle, sheep and possibly carabaos and goats are capable of initiating new infestations, if allowed to range especially in fields where the disease is widespread and abundant.

Clean culture would help a great deal in preventing the propagation and spread of the disease as the sclerotia are formed on the stems and leaves of dead plants, and also on pods underground. By the cultivation of the soil they are distributed rather widely in partly infested fields.

Avoid using stable manure or decaying matter for fertilizer. Any decaying organic matter may facilitate the carrying over of the fungus from year to year by means of sclerotial bodies.

As a measure of starving out the organism in the soil, good agricultural practices, such as rotation with plants not subject to *Sclerotium rolfsii* attack should prove beneficial.

Liming seems to retard the progress of the fungus in the soil and thus cause a diminution of the damage; at the same time it is beneficial to peanut culture.

Careful selection of well-developed seeds free from the disease is of utmost importance for planting in soils known to be free from the disease. Although kernels may carry hyphae of the fungus it is doubtful if they could survive the period of dry storage or stocking before they are sown with the seeds. Seeds bearing fresh mycelium of the fungus may not sprout because of fungus attack. Use only cured and newly-shelled seeds because they give greater percentage of germination, and disinfection is hardly necessary.

The results of experiments reported in this paper indicate that in infested soils it would be advantageous to plant resistant varieties of peanuts in order to minimize damage. Such va-

rieties as Virginia Jumbo and Tai-tau which exhibit sufficient resistance to Sclerotium wilt should be used.

## SUMMARY AND CONCLUSIONS

1. The Sclerotium wilt of peanut (*Arachis hypogæa* Linn.) appears to be one of the most destructive diseases of this crop and is found geographically distributed far and wide. The disease is important on account of growing interest in the cultivation of peanut, the introduction of new varieties for planting and the lack of systematic method of control.

2. Our information regarding this peanut wilt in the Philippines and its methods of control is still fragmentary.

3. The occurrence of Sclerotium wilt of peanut in the field may first be noted by wilting of plants and the association of the fungus, followed by the loss of the normal green color. Browning of the shanks then takes place. Soon the presence of a thick mat of white mycelium and the production of white to brown sclerotia may be noted at the base of wilted plants or on the surface of the ground. The underground parts of the plants may also be affected and these may be covered with the mycelium of the causal fungus, causing rotting of the gynophores, pods and roots.

4. The fungus is without doubt a strain of the cosmopolitan, soil-borne *Sclerotium rolfsii* Sacc. known the world over. Isolations of this fungus from peanut have proved pathogenic to the same host in artificial infection experiments. Peanuts infected while young usually die prematurely and those infected at maturity are much affected in their yielding capacity.

5. The host range of *Sclerotium rolfsii* in the Philippines is herein listed to serve as a guide to growers who practice crop rotation; they number fifty-four, seven of which are here reported for the first time. Fourteen others were produced artificially. Plants found susceptible in foreign countries and now in cultivation in the Philippines should bear close watching. The other control practices suggested should be resorted to in case the resistant varieties are not readily procurable.

6. Different varieties of peanuts grown in an infected field showed varying degrees of infection. Wilting ranging from 31.3 to 50.7 per cent of the plants was noted by actual counts.

7. Varieties used in field inoculation tests showed susceptibility to peanut wilt in the descending order as follows: (*a*) Va-

lencia; (*b*) Macapno; (*c*) Georgia Red; (*d*) White Improved Spanish; (*e*) Spanish; (*f*) Biit; (*g*) Cagayan No. 1; (*h*) San José No. 3; (*i*) Vigan Lupog; (*j*) Tirik; (*k*) Tai-tau; (*l*) Virginia Jumbo; and (*m*) Virginia Jumbo(a). The least infected varieties were, Virginia Jumbo(a), Virginia Jumbo, and Tai-tau while Valencia and Macapno were the most seriously infected.

8. Although the yearly results are not very consistent, the summarized results show a close and definite relation of the number of diseased pods to infection, and to a lesser degree also, the number of germinated pods.

9. As is to be expected infection is more severe during the wet season than during the dry period of the year.

10. Virginia Jumbo(a), Virginia Jumbo and Tai-tau are late-maturing varieties but they are heavy yielders. They produce large kernels with good dormancy quality. Most important of all, they are disease resistant.

11. The results of three years' experiments have shown that among peanuts the runner types are more resistant to Sclerotium wilt than the erect or semierect varieties. Subsequently the question of resistance to this disease of peanut hybrids possessing a combination of the resistant quality of one variety and the desirable agronomic characters of another will be a feasible objective. A histopathological study and inquiries leading to the nature of resistance may be undertaken later to follow the mode of destruction of the host cells in some detail and also to determine definitely what features are responsible for resistance.

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# ILLUSTRATIONS *

## PLATE 1

A hill of Valencia variety which completely succumbed to infection with *Sclerotium rolfsii* Sacc., showing the prostrate condition of the plant and accumulations of white and brown sclerotia at the base.

## PLATE 2

Pods obtained from two plants of Valencia showing underground infection, and shrunken shoots from germinated pods. Note the profuse growth of white mycelium on the surface and presence of the fungus on the stems of the wilted seedlings. x 0.8.

## PLATE 3

Peanut pods from a severely infected plant, Valencia variety, showing copious growth of the cottony mycelium of *Sclerotium rolfsii*, rendering all the pods unmarketable. x 1.

## PLATE 4

Five-day old cultures of *Sclerotium rolfsii* Sacc. on cut leaves of dapdap, *Erythrina variegata* Linn. var. *orientalis* (Linn.) Merr. (*Erythrina indica* Lam.) showing typical fan-shaped, coarse, white feathery vegetative growth; about $\frac{2}{3}$ natural size.

## PLATE 5

Fifteen-day old culture of *Sclerotium rolfsii* on chopped dapdap leaves sterilized in autoclave, to show formation of brown sclerotial bodies; natural size.

## PLATE 6

FIG. 1. Inoculated peanut plants showing the first stages of the disease at the right and the control plants at the left.

2. A more advanced stage of the disease resulting from artificial infection at the left pot and the check pot at the right.

## PLATE 7

Partial view of the experimental field, showing a few of the control plats taken 70 days after the date of planting. Photographed October 31, 1935.

## PLATE 8

A plat of Georgia Red variety inoculated with *Sclerotium rolfsii* Sacc., showing moderate susceptibility as evidence by the wilted and partly dying plants which can be seen only by a careful scrutiny.

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* Sixteen of the photographs used in this paper were taken from the writer's specimens by the Bureau of Science, and six by the Division of Publications, Department of Agriculture and Commerce, Manila, P. I.

PLATE 9

Control plat of Georgia Red variety photographed on the same day as the inoculated plat shown in Plate 8, exhibiting absolute freedom from the disease.

PLATE 10

Another plat of peanut, variety San José No. 3, showing great susceptibility produced by artificial infection. Note the thinness of growth on account of infection due to *Sclerotium rolfsii*. Compare with the healthy control plat in Plate 11.

PLATE 11

Control plat of the variety San José No. 3 which is completely free from infection.

PLATE 12

This picture shows a partial view of the experimental field. In the foreground is a plat of Valencia variety showing varying stages of infection as a result of artificial inoculation with *Sclerotium rolfsii*.

PLATE 13

A plat of Valencia under test for resistence to *Sclerotium rolfsii*, which proved the most susceptible variety. Note that nearly all the plants have been killed by the disease except a few in the background.

PLATE 14

An inoculated plat of peanut, Tirik variety, showing considerable resistance to Sclerotium wilt. Note the plant pointed by arrow which shows slight infection where only a portion of the individual plant is diseased.

PLATE 15

A plat of Virginia Jumbo (a), an exotic variety of the runner type tested for resistance to *Sclerotium rolfsii*, which proved to be very little, if at all, affected by it.

PLATE 16

A plat of a tolerant peanut variety Tai-Tau, having growth characteristics very similar to Virginia Jumbo, photographed 26 days after inoculation. Note also the infections in the neighboring variety at the right which is partly visible.

PLAT 17

A plat of an exotic peanut variety, Virginia Jumbo, that has consistently shown considerable resistance to *Sclerotium rolfsii*. Photographed 26 days after inoculation.

PLATE 18

An infected stem of Georgia Red (left), showing severe wilting compared with that of Virginia Jumbo (right), exhibiting no apparent sign of wilting effect in spite of the presence of the inoculum at the base of the stem. Both plants got infected at the same time.

PLATE 19

Three stems of Virginia Jumbo (left), inoculated with *Sclerotium rolfsii* Sacc., showing scarcity of growth of the fungus even under extremely favorable weather and soil conditions, compared with the luxuriance of mycelial growth on the stems of a susceptible variety, Georgia Red. Inoculated simultaneously and later photographed on same date. Approximately x 1–1/20.

PLATE 20

Two split stems of a resistant variety, Virginia Jumbo (left), showing very slight evidence of internal invasion or appreciable injury as a result of inoculation. The white stuff in the hollow of the stems is the pith. Compare with a diseased stem of susceptible Georgia Red at the right. Note the discoloration at the seats of infection, pointed by arrows, the inner tissues having been partly consumed by the inoculum. Approximately x 1–3/20.

PLATE 21

Diseased pods (first two upper rows) of Georgia Red variety dug up with the inoculated plants at time of harvest, showing infection of pods which took place underground. Note the development of sclerotial bodies on the surface of the pods and presence of abundant white mycelia inside the opened pods as compared with the healthy pods in the third row. Approximately x 1.08.

PLATE 22

Pods of Valencia variety (two rows at top) infected with *Sclerotium rolfsii*, showing its destructive effects as evidenced by the presence of mycelia and white to brown sclerotia of the inoculum compared with the healthy pods at the bottom. x 1.

TEXT FIGURES

FIG. 1. Plan of the experimental field, showing the arrangement of plats, distribution of the varieties, and distancing.

2. Representing graphically the effect of artificial inoculation on the yield for the three-year period.

3. Chart showing by year the effect of inoculation on the pods underground.

4. Chart showing the effect of *Sclerotium rolfsii* infection on the yield, based on three years' experiments.

5. Chart showing the relation of the number of infected plants to the number of diseased and germinated pods, based on three years' experiments.

PLATE 1.

PLATE 2.

PLATE 3.

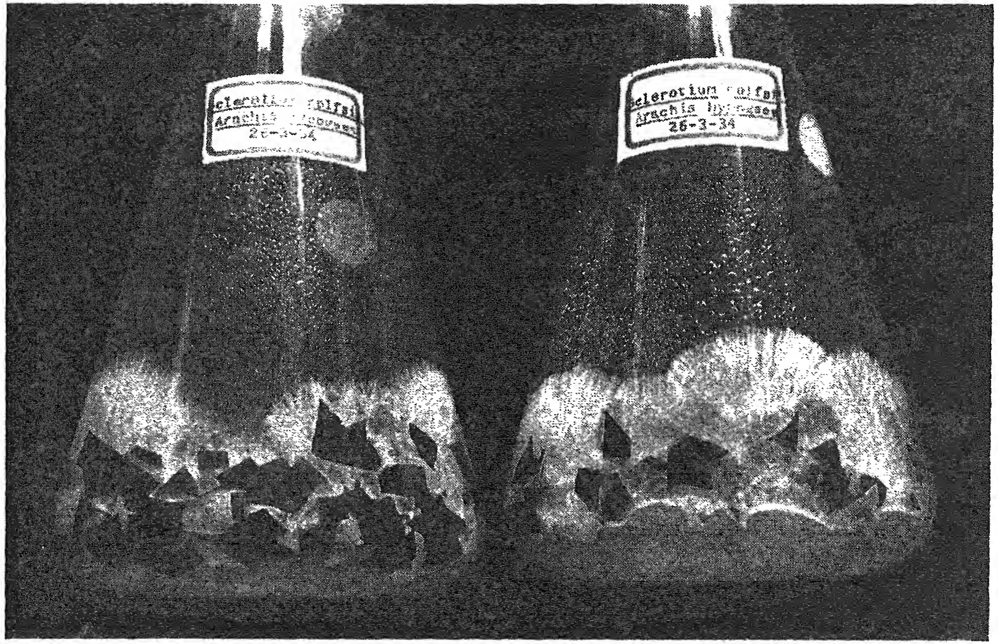
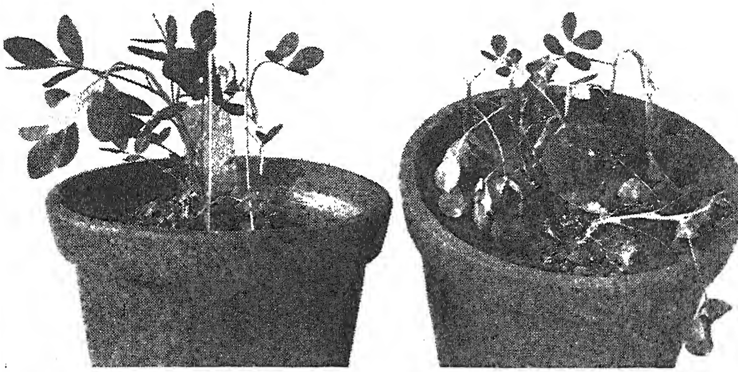



PLATE 4.


PLATE 5.



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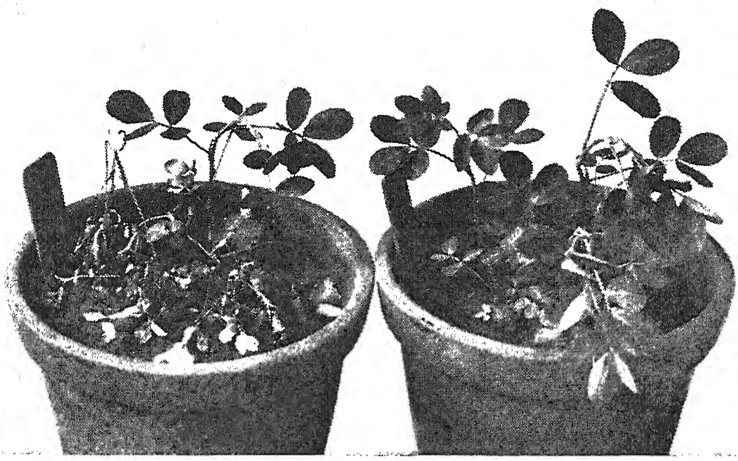

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PLATE 6.

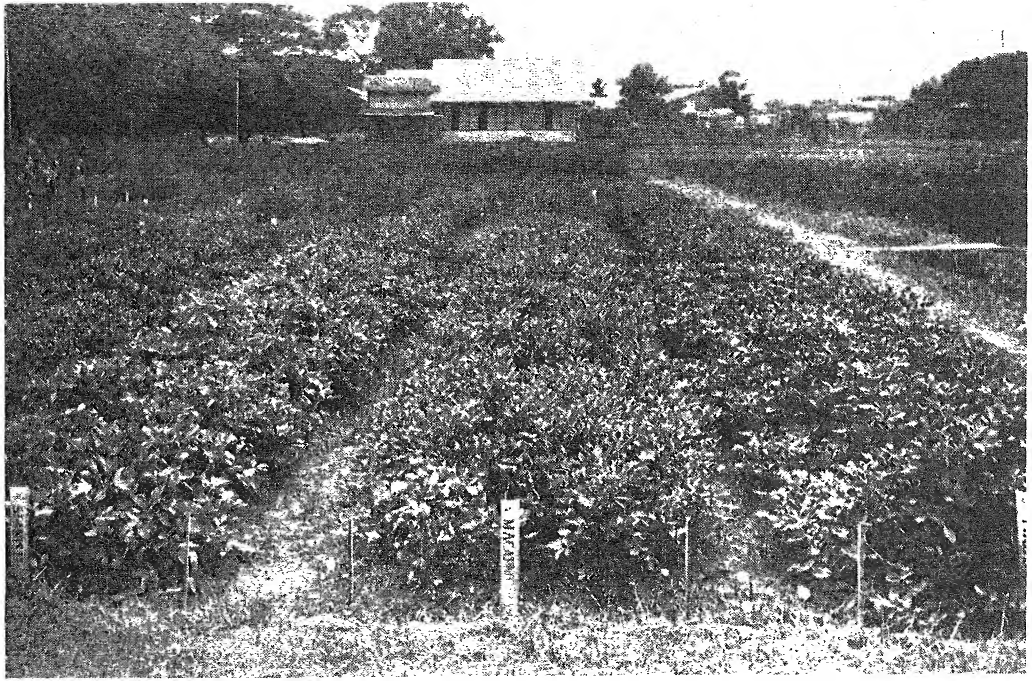

PLATE 7.

PLATE 8.

PLATE 9.

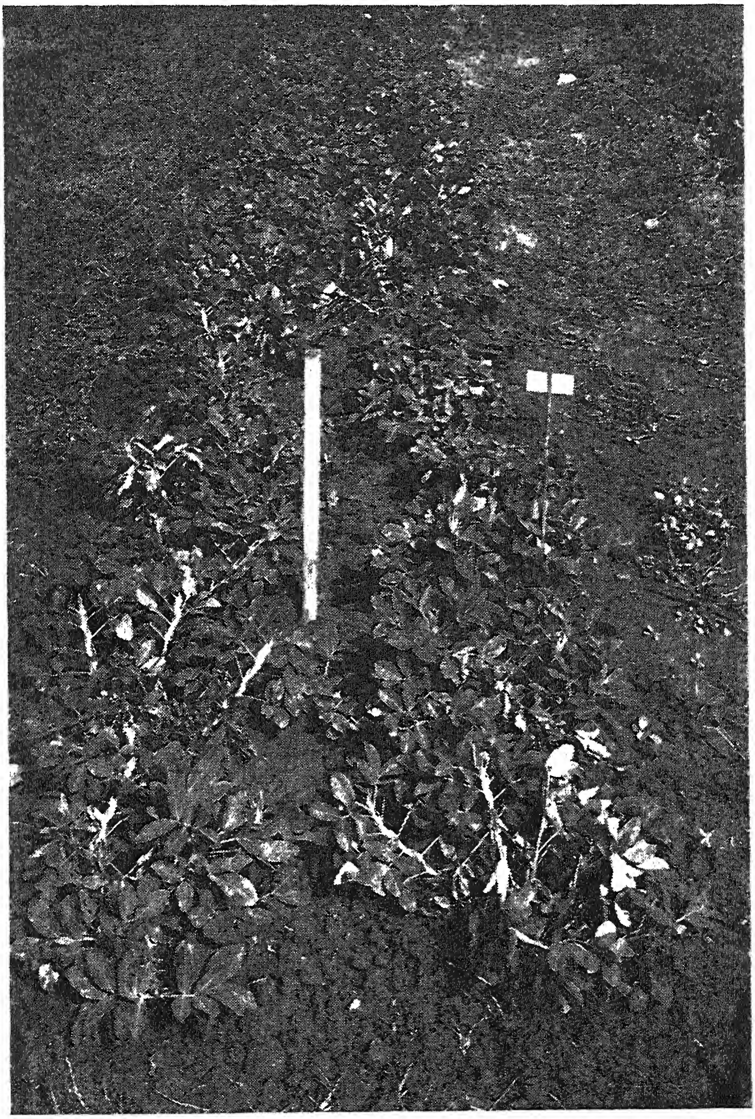

PLATE 10.

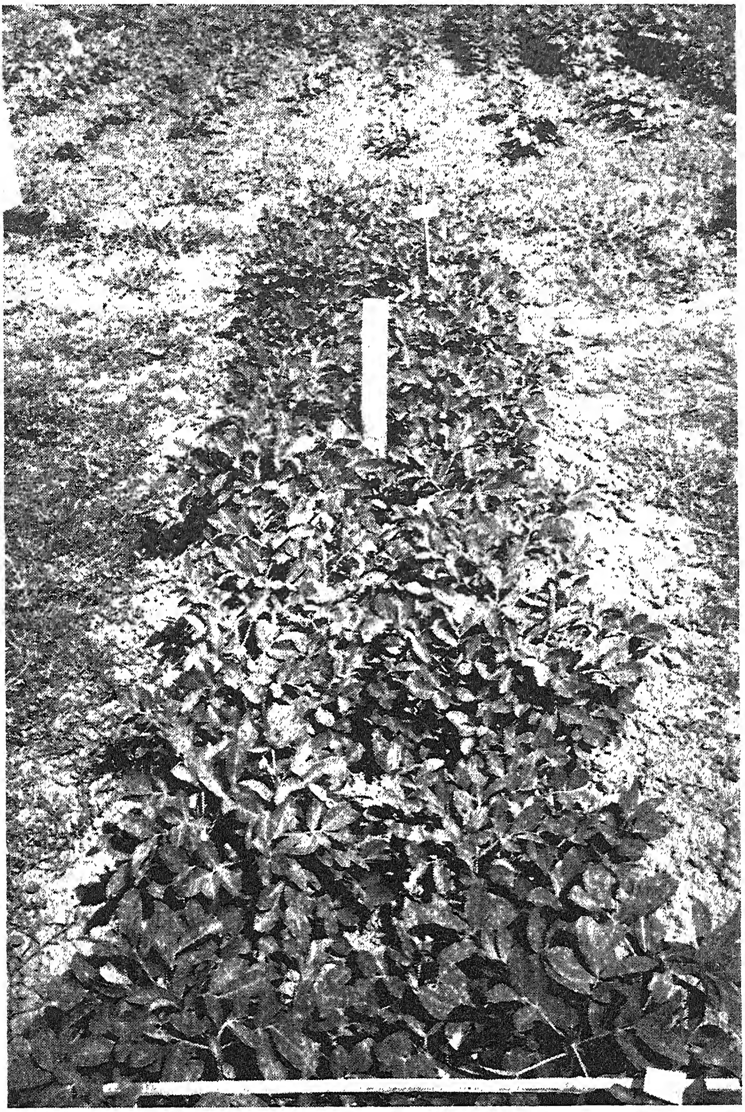

PLATE 11.

PLATE 12.

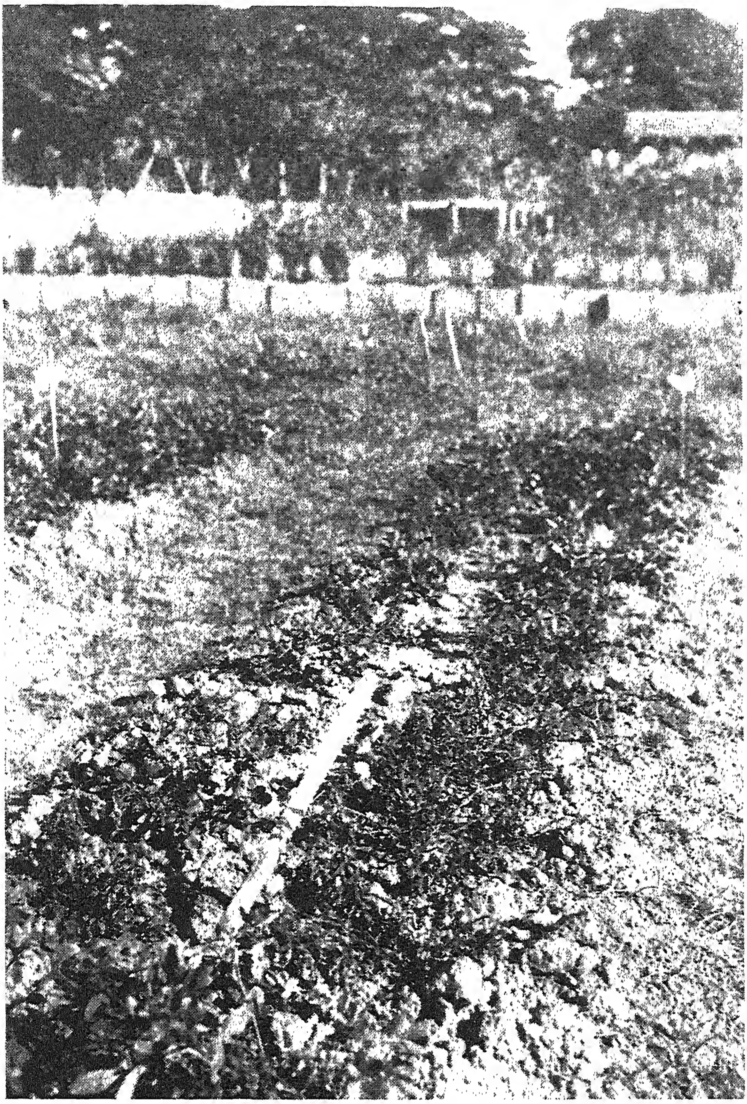

PLATE 13.

PLATE 14.

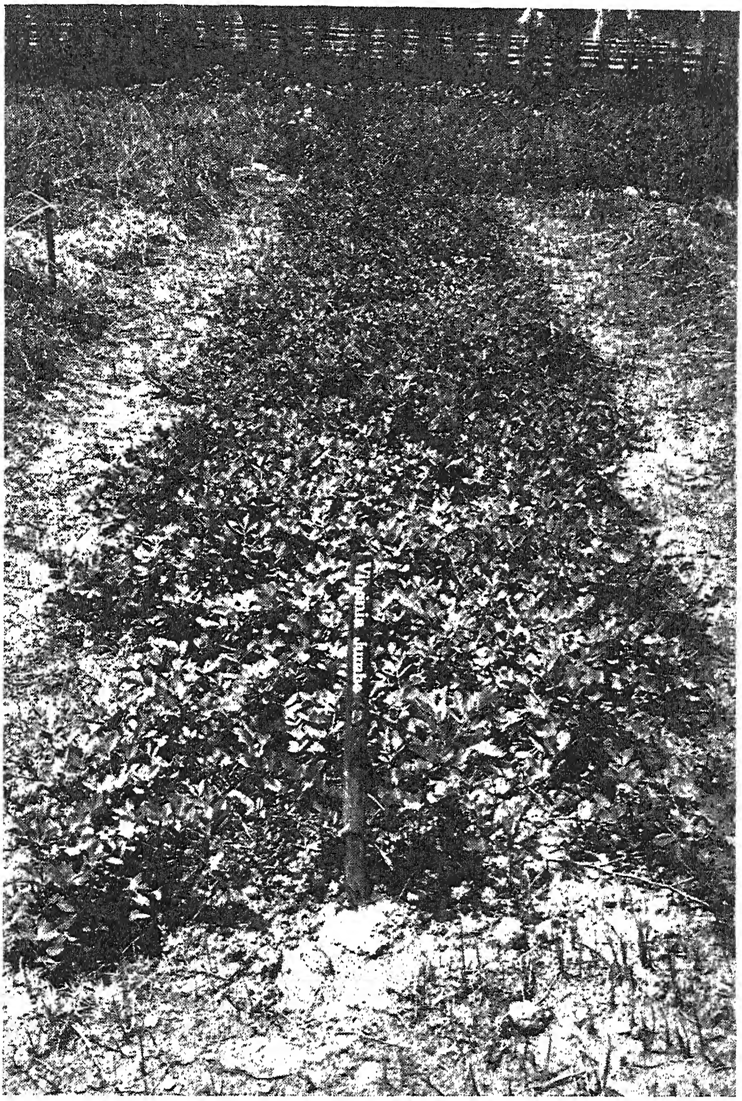

PLATE 15.

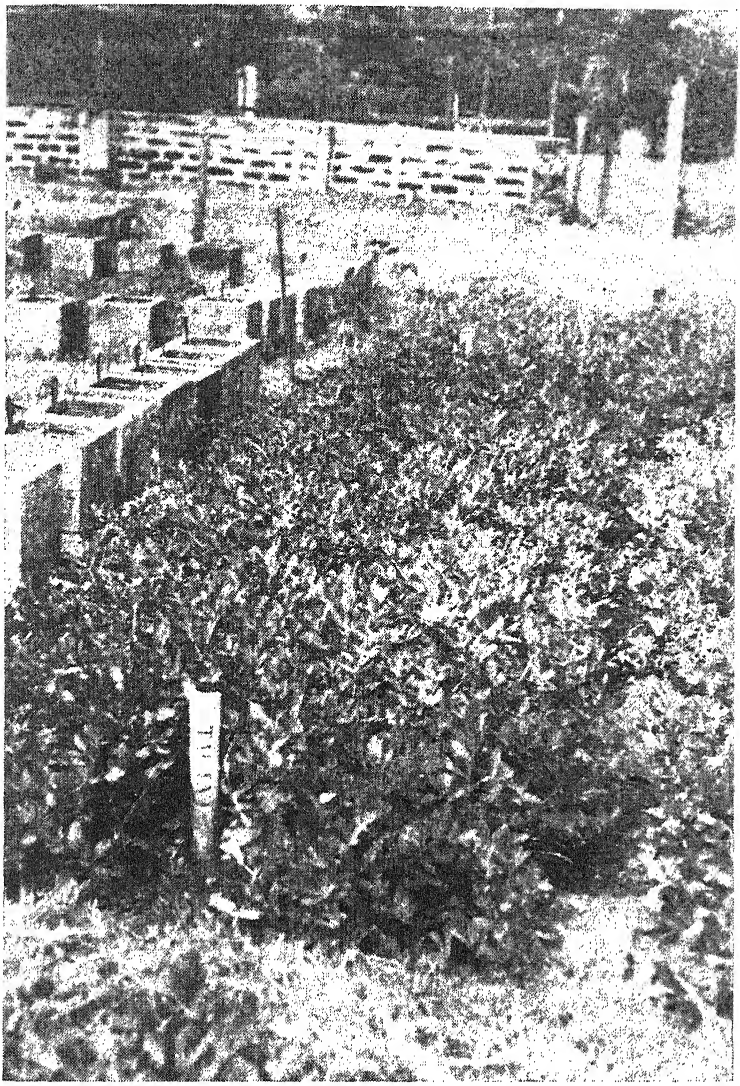

PLATE 16.

PLATE 17.

PLATE 18.

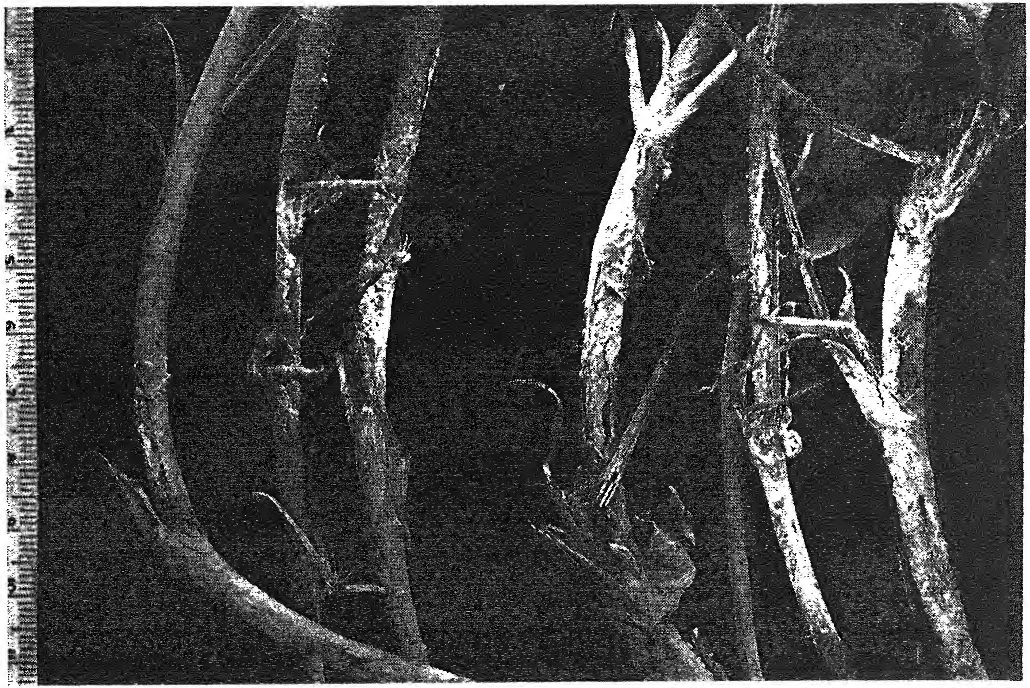

PLATE 19.

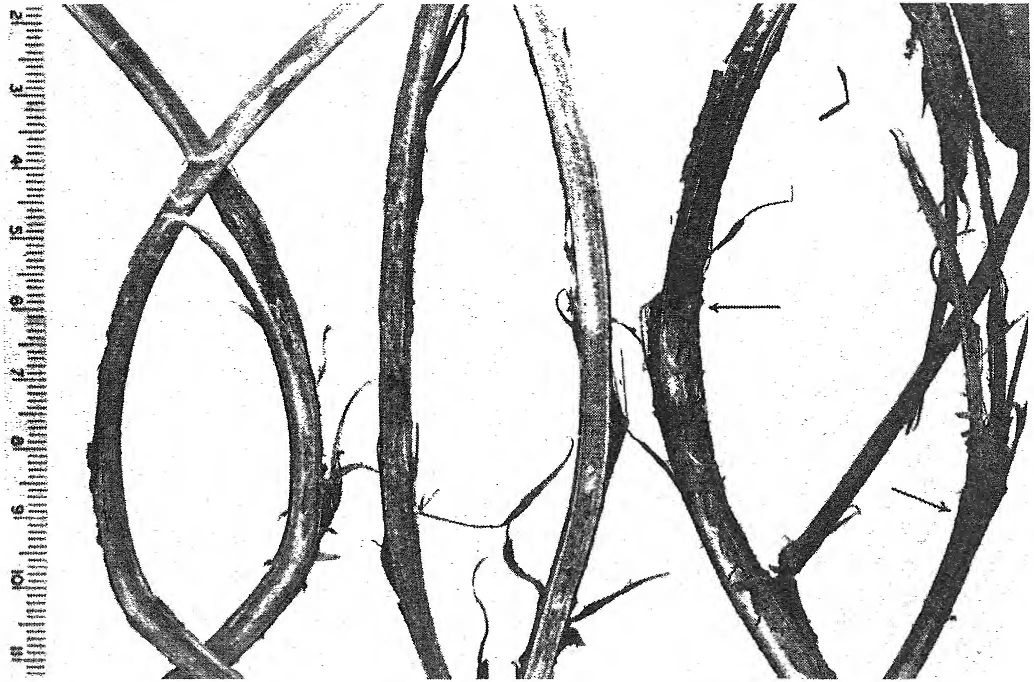


PLATE 20.

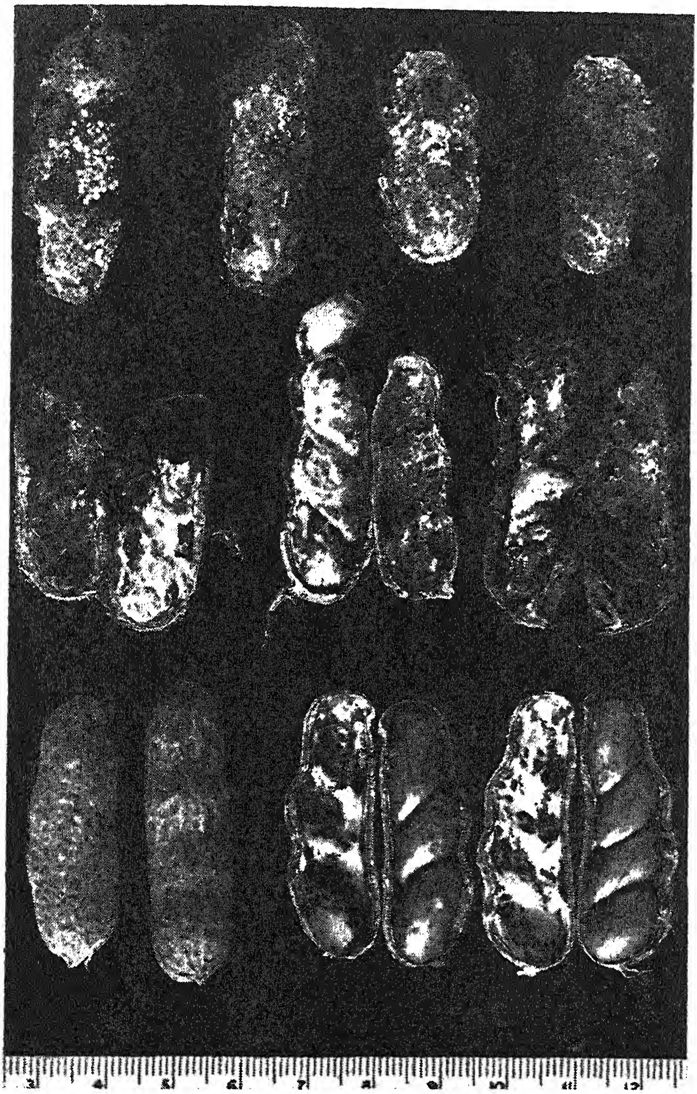

PLATE 21.

PLATE 22.

# THE MELON FLY (*DACUS CUCURBITÆ* COQUILLET)

By ANDRÉS PONCE

*Of the Plant Pest and Disease Control Division*
*Bureau of Plant Industry*

FOUR PLATES AND TWO TEXT FIGURES

## INTRODUCTION

Cucurbits are important and popular vegetables among the Filipinos because they can be easily grown in the backyard and the fruits are easily sold or marketed. The growing of patola, amargoso, upo, squash, cucumber, condol, and the like, either for market or for home consumption is being done in almost every home in our rural districts. A study of the insects destructive to these plants, of which melon fly is one of the most common, is therefore important.

It is the aim of this paper to emphasize to the vegetable growers the economic destruction done by the melon fly as one of the major pests of cucurbitaceous plants and to present some means of minimizing its damage. The data herein reported were obtained during 1932, 1935, and the first semester of 1936 in the Entomology Laboratory of the Bureau of Plant Industry, Manila.

## SYSTEMATIC POSITION

The melon fly was included under Dacinæ, a subfamily of Trypetidæ by Back and Pemberton (1917), Trypaneidæ by Bezzi (1919), and Trupaneidæ by Curran (1934). The synonyms of the species are as follows:

*Bactrocera cucurbitæ* Coq. (Back and Pemberton). (1917).
*Chætodacus cucurbitæ* Coq. (Bezzi). (1919).
*Dacus cucurbitæ* Coq. (by most authors).

## REVIEW OF LITERATURE

Essig (1913) gave credit to C. F. Baker as the authority of the information that *Dacus cucurbitæ* Coq. is abundant in the Philippines. Tuason (1917) estimated its destruction on cucurbits from 30 to 40 per cent. Bezzi (1919) described specimens collected also by Baker from Makiling, Los Baños, Prov-

ince of Laguna, and in the province of Davao. Woodworth (1912) reported 17 host plants in the Islands. In the Philippines the life history of the melon fly has not been adequately studied.

Froggatt (1909) found that the melon fly thrives in India and Ceylon on melons, cucumbers, bitter gourds, and eggplants. He found out that the flies are not attracted to citronella oil. Fletcher (1917) stated that the melon fly is a serious pest of cucurbits and widely distributed throughout India and Burma. Muir (1914) cited *Dacus cucurbitæ* Coq. as being common and harmful to cucumbers and melons in Formosa. Hill (1915) listed *Dacus cucurbitæ* Coq. as a pest of melon, pumpkin, and marrow squash in Northern Australia.

In Hawaii Back and Pemberton (1917) and (1918) made a more or less complete study of the biology of this insect and conducted some experiments on its control.

## ORIGIN AND DISTRIBUTION

Back and Pemberton claimed that the original home of the melon fly is the Indo-Malayan region. It is present in India, Ceylon, Java, Timor, Australia, Southern China, Singapore, Japan, Hawaii, Hongkong, and the Philippines.

The species may have been introduced into the Philippines from India, its original home, or from Japan and China through imported cucurbit fruits before there was any plant quarantine.

## ECONOMIC IMPORTANCE

The melon fly is one of the destructive pests on cultivated species of cucurbits. In Hawaii the melon fly attacks the roots, stems, foliage, blooms, and fruits of cucurbits and other vegetables so that the raising of these crops as an industry has been seriously hampered. In the Philippines the injuries of the melon fly appear to be confined only to the fruits of the host plants. Nevertheless, these damages reach serious proportions.

## MANNER OF INJURY

The adult female fly lays eggs by inserting them inside the fruits through wounds on the skin caused by its ovipositor. As soon as the eggs hatch, the maggots destroy and convert the inside pulp of the fruits into a semi-liquid mass. On young fruits, infestation very often results into suppressed growth and deformities which render them entirely useless (Plate 3, figs. 2, 3). Instances were observed in which adult flies infested sound

fruits of amargoso, cucumber, and patola left exposed in the market, so that those fruits after two or three days became useless due to the presence of maggots inside.

### HOST PLANTS

The writer observed the pest in nine host plants, the "amargoso" and "patola" being the most susceptible, as follows:

1. Amargoso (*Momordica charantia*).
2. Cucumber (*Cucumis sativus*).
3. Melon (*Cucumis melo*).
4. Patola (*Luffa cylindrica*).
5. Squash (*Cucurbita maxima*).
6. Upo (*Lagenaria leucantha*).
7. Water melon (*Citrullus vulgaris*).
8. Eggplant (*Solanum melongena*).
9. Tomato (*Lycopersicum esculentum*).

In the host index prepared by Woodworth (1921) 17 host plants of the melon fly were recorded, which includes the following beside those listed above:

1. Passion flower (*Passiflora* sp.).
2. Cowpea (*Vigna sinensis*).
3. Papaya (*Carica papaya*).
4. Guayabano (*Annona muricata*).
5. Ates (*Annona squamosa*).
6. Custard apple (*Annona reticulata*).
7. Mango (*Mangifera indica*).
8. Guava (*Psidium guajava*).

### LIFE HISTORY AND HABITS

#### METHODS OF STUDY

In rearing the melon fly, battery jars, 16.5 by 20.5 centimeters provided with cheese cloth covers, were used. Food was supplied to the flies in the jar using the method described by Peterson (1934) in rearing blow flies, which consists of water slightly sweetened with brown sugar placed in an inverted beaker or vial on small Petri dish or syracuse watchglass, provided with filter paper or blotting paper at the bottom (Plate 2). This way of feeding prevented the flies from getting entangled or getting stuck to the food and at the same time furnished the flies with a constant supply of food from 5 to 6 days. The insects were also provided with sliced or whole fruit of the host for oviposition. Slight injuries were made in the skin of the fruit to facilitate the laying of the eggs.

## DESCRIPTIONS

*The Adult.*—Bezzi (1919) distinguished the adult melon fly from other species of fruit flies in the Philippines by the three pairs of lower orbital bristles, the middle yellow stripe of the back of the mesonotum, and the peculiar wing pattern with broadly infuscated hind crossvein. The length is usually not over 6 to 6.5 millimeters (Plate 1, fig. 5). Froggatt (1909) gave the following original description of Coquillet to which my specimens conformed:

> Head, light yellow, the occiput, except the sides and upper margin, reddish yellow, and ocellar black dot, front marked with brown spot in front of its center and with three pairs of orbital brown dots, a black spot on each side of the face near the middle, and a brown spot on the middle of each cheek; antennæ, palpi, and proboscis yellow, the latter mottled with brown; thorax, reddish-yellow, the humeri, median vitta on the posterior half of the mesonotum, another on each side, above the insertion of the wings, uniting with an irregular band which extends upon the pleura to the upper part of the sternopleura, also a large spot on each side of the metanotum, encroaching upon the hypopleura, light yellow; scutellum, except its extreme base, light yellow, bearing two bristles; abdomen light yellow on first two segments, reddish-yellow on the others, the extreme base, a facia at the bases of the second and third segments, usually a lateral spot on the fourth and fifth, also a dorsal vitta on the last three segments, blackish or brownish; first segment of the ovipositor of the female slightly longer than the fifth segment of the abdomen. Wings hyaline, the apex of the subcostal cell, from a short distance in front of the apex of the auxilliary vein, the marginal and submarginal cells, the median third of the first basal cell, and a large spot in upper outer corner of the first posterior cell, brown, this colour encroaching on the third posterior cell and bordering the sixth vein almost to its apex; posterior crossvein bordered with brown, this colour extending to the hind margin of the wing; upper end of the small crossvein is also bordered with brown. Halteres light yellow. Legs light yellow, the broad api es of the femora and the last four joints of the tarsi reddish-yellow; hind tibiæ reddish-yellow or dark brown.

## THE EGG

The egg of the melon fly is glistening white and is about 1.4 to 1.7 millimeters long and 0.25 millimeter wide. It is ellipsoidal and slightly curved. The eggs are deposited in the slightly injured rind of the host fruits usually to a depth of 4 to 9 millimeters (Plate 1, figs. 1 and 2).

## THE LARVA

The maggot of the melon fly passes through three stadia or instars. The external structures of every stadium are as follows:

*First instar.*—Size, about 2 by 0.08 millimeters; head pointed; provided with very tiny mouth hooks or mandibles; without anterior spiracles but minute posterior spiracles present with two tiny slits on each stigmal plate surrounded by three groups of fine hairs or bristles.

*Second instar.*—Size, about 4 by 1.4 millimeters; mouth hooks or mandibles about two times the first instar. Anterior spiracles with 18 lobes, divided into two arcs which are fan-shaped and located at the hind edge of the second segment. Posterior spiracles consist of three slits with four sets of fine hairs on each stigmal plate.

*Third instar.*—The full grown larva is about 10 by 2.5 millimeters and it has 12 segments. Head slightly bilobed and pointed at the anterior apex with two antennal protuberances. In the center of the lobe are developed black mouth hooks or mandibles which are about twice as much as the second instar. Anterior spiracles large, about two times that of the former instar and have the same number of lobes but more uniform in a single arc. The posterior segment is more or less flat and bears the posterior spiracles which are very well developed and somewhat more elevated than those of the second stage or instar. There are four sets of longer hairs than the preceding instar and two more or less protuberances above the stigmal plates. The anus is located below the stigmal plates and between the pair of more or less connected tubercles of the ventro-caudal surface of the last segment. In almost every segment spinulose area with scattered hooklets are present on the ventral side (Plate 1, fig. 3).

### THE PUPA

The puparium is 5.5 millimeters; elliptical and has 12 visible segments; generally dark testaceous. The apex of the first segment shows indication of the larval mouth hooks or mandibles and on both sides are the anterior spiracles with their lobes. A short black line is located on the last segment between the posterior spiracles and the anal opening, which is transformed into a small black spot. Spinulose areas are shown on the ventral side in almost every segment as two narrow bands but do not extend to the lateral sides of each segment (Plate 1, fig. 4).

### LENGTH OF LIFE CYCLE

*Incubation period.*—In this work the eggs were found to hatch within a minimum period of 0.5 day, a maximum of

4 days and an average period of 1.73 days as shown in Table 2. No change in color was observed on the eggs from the time they were laid up to the time when they hatched.

*Larval period.*—The maggots after coming out from the egg-shells begin making tunnels and destroying the inside content of the fruits and sometimes including the seeds (Plates 3 and 4, fig. 1). Full grown maggots are generally white but very often the color changes to greenish yellow depending upon the kind of the host fruit. For instance the maggots feeding on amargoso and patola are darker than those feeding on cucumber. If disturbed the maggots can leap a few centimeters high. Maggots leave the infested fruit through an exit hole made by them and then drop to the ground wherein they pupate (Plate 4, fig. 2).

Table 3 shows the average duration of the larval instars of 60 cultures on five different hosts. The first stadium lasted for 1.38 days; the second, 2.27 days; and the third or last, 2.87 days. The length of the larval period was 5 days, when reared in papaya fruit, which was the shortest among the group at a mean temperature of 29.15° C. In "upo" the length of the larval period was 6 days at 30.36° C. Rearing the melon fly in patola and amargoso, the most favored hosts, gave almost the same length of larval period which were 6.49 and 6.50 days at the mean temperatures of 30.34° C. and 30.36° C., respectively.

The average length of the larval period as given in Table 3 was 6.12 days as compared with 6.06 days in Table 2. The slight difference may be due to the slight disturbances under which the maggots were subjected during the observations, and may be attributed to the effects of different host fruits. The minimum length of larval period as given in Table 2 was 4 days and the maximum being 6 days.

*Pupal period.*—The full-grown maggots in order to pupate left the infested fruits (Plate 4, fig. 1), dropped to the soil, and went down to a depth of 7 to 15 centimeters. In cases where the surface soil was very hard it was observed that pupation took place just beneath any object laying on the ground. The pupation was accomplished for about 50 minutes (Plate 1, fig. 4).

The pupal period ranges from 7 to 11 days with an average period of 8.59 days (Table 2).

*From egg laying to emergence.*—The length of time from egg laying to emergence of the adult flies in 32 cultures is shown in Table 2. The minimum number of days was 12.5; the maximum, 21 days; and the average, 16.5 days.

OBSERVATIONS ON THE ADULT FLIES

*Emergence.*—The emergence of the adult flies usually occurred from early in the morning up to about 10 o'clock. The process was by breaking the wall at the anterior end of the puparium with the aid of the ptilinum forcing its way out of the soil. Newly emerged adults were pale in color with wings still folded. After about 30 minutes the wings were fully expanded and the entire body hardened.

*Sex ratio.*—In order to determine the corresponding number of males and females, counts were made on the emerging adult flies from infested fruits collected in the field. The ratio is shown in Table 4. From 30 cultures the average was 22.3 males and 24.5 females or a ratio of 0.4765 to 0.5237. The ratio is almost equal.

*Mating.*—Mating usually occurred from 6 in the afternoon to 6 in the following morning, and in some cases up to about 9 a. m. The process was accomplished by the male embracing the abdomen of the female and the head of the male touching the scutellum of the female. It was observed that the pair was able to wander while in copula and often one female was fertilized by several males.

*Oviposition.*—The pre-oviposition period was observed on 20 adult female flies as shown in Table 5. The minimum period was 7 days with a maximum of 26 days, the average being 15.9 days. Oviposition usually lasted from 0.4 to 2.2 minutes with an average of 1.1 minutes.

A female fly which is about to lay her eggs wanders around the surface of the host fruit looking for suitable spot. Upon locating she begins laying her eggs by first extending her ovipositor in full length and then bends it forward to form an almost acute angle with the axis of the abdomen. Then it inserts her ovipositor deep into the fruit by an up and down motion until the desired depth is attained.

The duration of egg laying or period of fecundity was also determined with the same flies. The minimum was 39 days and the maximum 95 days, with an average of 53.6 days (Table 5).

*Rate of oviposition.*—Observations on the rate of oviposition were made on 10 adult female flies which were carefully reared in battery jars supplied daily with fresh food (sugar solution) and fruits of "patola" and "amargoso." As shown in Table 6, the highest number of eggs was laid by No. 9 being 494, next

was female No. 4 with 461 eggs, and then followed by female No. 10 with 420 eggs. The least number was laid by No. 2 which was 114. Flies Nos. 6 and 8 escaped accidentally, so the data on them are incomplete.

The daily rate of oviposition was also obtained. It will be noted that the melon flies were able to lay eggs almost daily at times and then with greater intervals at other times. The greatest number of eggs laid per day was recorded on the first laying day of fly No. 6, being 45 eggs. The next highest was laid by the tenth laying of fly No. 9 and this was 43 eggs. This was followed by the 4th and 25th laying of fly No. 4 amounting to 40 eggs. The least number laid by the flies was 1 to 2 eggs

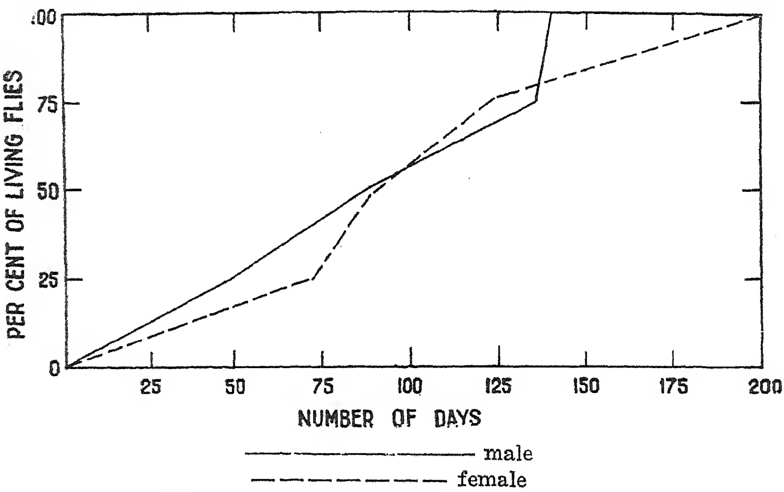


CHART 1.—Longevity of male and female in mass culture.

per day. The average daily rate of oviposition recorded for flies Nos. 1 to 10 were 12, 8, 12, 14, 13, 19, 27, 9, 18, and 16, respectively. The highest oviposition average was made by fly No. 7 and the least was by fly No. 2.

*Longevity of adult males and females.*—Back and Pemberton (1917) observed a female melon fly to have lived for 431 days in Hawaii when kept well supplied with food. Under insectary conditions at the Central Experiment Station, Manila, adult flies lived in a much shorter time. The longevity of adult male and female flies was taken from individual cultures (Table 7). In general, the length of the life of adults was very irregular, ranging from 30 to 90 days for the males and 36 to 143 days for the females. It will be seen that the female melon flies lived longer than the males as shown by their averages, which

are 70.9 days for females and 60.8 days for males. This was true also on mass cultures of males and females as shown in Chart 1.

CONTROL MEASURES SUGGESTED

*1. Collecting and destroying infested fruits.*—This is a practical method of reducing the damage by this pest, since every infested fruit destroyed means a proportionate decrease of melon fly population capable of infesting other fruits. Infested fruits collected may be destroyed either by burning or burying them for not less than a meter deep in the soil, or by carefully placing them in an empty tin can or barrel properly covered and with kerosene or a strong solution of lime for at least 3 days. Throwing the collected infested fruits into pits is not advisable because the mature maggots will have the chance to pupate in the soil and develop into adults.

*2. Bagging the fruits.*—This method is a means of protecting the fruits from future infestation by preventing the female flies from ovipositing in them. The material that may be used are Manila paper, newspapers, worn out clothes, etc. Obviously, the newspaper is the most economical to use. It was, however, observed that the female flies were able to oviposit in fruits when the bags were placed in contact with them so it is best to employ this method during the dry season.

The practice of bagging the fruits may be profitably employed by small growers, especially in their back yards. In the growing of cucurbits on a large scale, bagging the fruits requires a large amount of materials; besides, the work is rather tiresome, but even then it would pay to take the trouble to save the crop, especially where labor is cheap.

CHEMICALS TESTED

Laboratory experiments with poisoned baits were conducted and the following formulæ were used:

| | |
|---|---|
| 1. Copper sulphate | 1 gram |
| Brown sugar | 25 grams |
| Water | 1 liter |
| 2. Lead arsenate | 2 grams |
| Brown sugar | 20 grams |
| Water | 1 liter |
| 3. Calcium arsenate | 3 grams |
| Brown sugar | 20 grams |
| Water | 1 liter |
| 4. White arsenic | 1 gram |
| Brown sugar | 15 grams |
| Water | 1 liter |

| | | |
|---|---|---|
| 5. | Sodium arsenite | 2 grams |
| | Brown sugar | 15 grams |
| | Water | 1 liter |

The first formula was adapted from Darby and Kapp (1934) and the second formula from Miller and McBride (1931) with some slight modifications, while the last three are original. Each test was conducted in triplicate, 25 flies being used in each trial. The baits given above were introduced to the melon fly culture in the battery jar by spraying the solution on the inner side wall of the jar and by wetting a piece of cotton with the poison solution and placed inside the jar. Chart 2 and Table 1 show the result of the experiments.

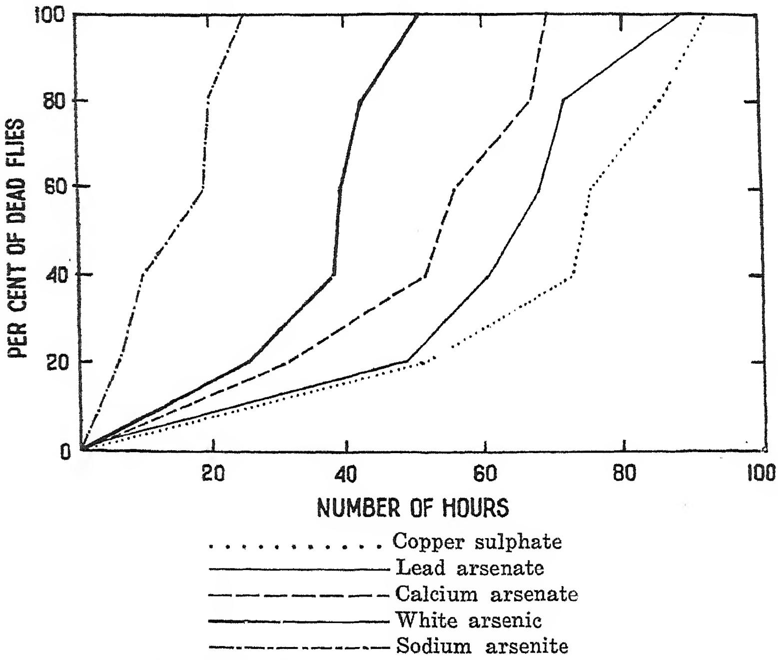


CHART 2.—The toxicity of five insecticides on melon flies.

Among the insecticides used, sodium arsenite gave the most promising results with white arsenic next. With sodium arsenite there was registered 20 per cent mortality after 6 hours, 40 per cent after 10 hours, 60 per cent after 19 hours, 80 per cent after 20 hours, and 100 per cent mortality after 29 hours. With white arsenic 20 per cent of the flies died after 26 hours, 40 per cent after 38 hours, 80 per cent after 44 hours, and 100 per cent died after 53 hours. The calcium arsenate treatment

showed a mortality of 20 per cent after 32 hours, 40 per cent after 52 hours, 60 per cent after 55 hours, 80 per cent after 67 hours, and 100 per cent after 68 hours. With the first two formulæ the effect was quite slow as all flies died after 88 hours and 92 hours, respectively. Field tests are necessary in order to ascertain the practicability of using poisoned baits under field conditions—at least those found most effective in the laboratory.

## NATURAL ENEMIES

In the course of this study only one species of parasites was reared several times on infested fruits of "amargoso" and "patola" collected from the field. The percentage of parasitism as observed in this work appears to be low. According to F. Q. Otanes of the Plant Pest and Disease Control Division of this bureau, the parasite apparently agrees with the descriptions of *Opius fletcheri* Silvestri,[1] a braconid, alive specimens of which were introduced by him into the Philippines from Hawaii in 1923. Mr. Otanes stated, however, that the identity of the parasites needs to be verified by sending specimens to authorities in Hawaii or in India.

## SUMMARY AND CONCLUSIONS

1. Cucurbits belong to an important group of vegetables in the Philippines, so the study of their most harmful pests is important.

2. The melon fly is one of the major pests of cucurbits here and in other countries. The synonymy of the species is as follows:

*Bactrocera cucurbitæ* Coq. (Back and Pemberton).
*Chætodacus cucurbitæ* Coq. (Bezzi).
*Dacus cucurbitæ* Coq. (by most authors).

3. The original home of the melon fly is the Indo-Malayan region and this species was probably introduced long ago into the Philippines from India, China, or Japan through commerce before there was any plant quarantine work in the Philippines.

4. In the Islands the melon fly confines its attacks on the fruits of the host plants and the infested fruits become useless for the market.

5. There are 17 host plants under 7 families but only 9 of them were encountered in the present study.

[1] The alive specimens were furnished to Mr. F. Q. Otanes by Mr. D. T. Fullaway, an entomologist, in Hawaii.

6. Incubation period, 0.5 to 4 days with an average of 1.73 days; three larval instars, first stadium, 1.38 days, second stadium, 2.27 days, and the last stadium 2.87 days; larval period 6.12 days; pupal period 7 to 11 days with an average of 8.59 days; from egg to emergence 12.5 to 21 days with an average of 16.5 days.

7. The emergence of adult flies occurred from early to about 10 o'clock in the morning; the proportion of sexes from 30 cultures was 22.3 males to 24.5 females; mating usually occurred from 6 o'clock in the afternoon to 6 o'clock in the morning; pre-oviposition period, 7 to 26 days with an average of 15.9 days; oviposition lasted from 0.4 to 2.2 minutes.

8. The highest number of eggs daily laid by a female was 45 and the lowest was one and the total number of eggs laid individually ranged from 114 to 494.

9. The length of life of the female flies was from 36 to 143 days, the average being 70.9; that of the male ranged from 30 to 90 days and the average was 60.8.

10. The practical methods of reducing the damages of the melon fly are by collecting and destroying the infested fruits, and by bagging the fruits from the time they begin to form.

11. Baits were tried in the laboratory with copper sulphate, lead arsenate, calcium arsenate, white arsenic and sodium arsenite as the toxic agents. The white arsenic and sodium arsenite were found more toxic to the flies than the copper sulphate, lead arsenate, and calcium arsenate.

## ACKNOWLEDGMENT

The writer gratefully acknowledges the encouragement and useful suggestions given by Dr. Gonzalo Merino and Mr. Faustino Q. Otanes, Chief, and Assistant Chief, Plant Pest and Disease Control Division of this bureau, respectively, during the progress of this work. His thanks are also due to Mr. Santiago R. Capco for his help in the preparation of the manuscript.

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TABLE 1.—*Showing the effect of some insecticides on adult melon flies*

| Insecticides | Sugar | Water | Number of hours the flies died | | | | |
|---|---|---|---|---|---|---|---|
| | | | 20 per cent | 40 per cent | 60 per cent | 80 per cent | 100 per cent |
| | *Grams* | *Liter* | | | | | |
| Copper sulphate......1 gram | 25 | 1 | 52 | 73 | 76 | 86 | 92 |
| Lead arsenate.......2 grams | 20 | 1 | 49 | 61 | 68 | 73 | 88 |
| Calcium arsenate....3 grams | 20 | 1 | 32 | 52 | 55 | 67 | 68 |
| White arsenic........1 gram | 15 | 1 | 26 | 38 | 39 | 44 | 53 |
| Sodium arsenite.....2 grams | 15 | 1 | 6 | 10 | 19 | 20 | 29 |

TABLE 2.—*Life history*

| Culture number | Incubation period | Larval period | Pupal period | Length of time from egg to emergence |
|---|---|---|---|---|
| | *Days* | *Days* | *Days* | *Days* |
| 1 | 1.0 | 6 | 7 | 14.0 |
| 2 | 3.0 | 9 | 7 | 20.0 |
| 3 | 3.0 | 6 | 7 | 16.0 |
| 4 | 4.0 | 7 | 8 | 19.0 |
| 5 | 3.0 | 4 | 10 | 17.0 |
| 6 | 0.5 | 7 | 9 | 16.5 |
| 7 | 1.0 | 8 | 8 | 17.0 |
| 8 | 0.5 | 7 | 9 | 16.5 |
| 9 | 0.5 | 7 | 9 | 16.5 |
| 10 | 1.0 | 7 | 11 | 19.0 |
| 11 | 2.0 | 6 | 9 | 17.0 |
| 12 | 1.0 | 7 | 10 | 18.0 |
| 13 | 2.0 | 4 | 11 | 17.0 |
| 14 | 3.0 | 8 | 7 | 18.0 |
| 15 | 3.0 | 7 | 9 | 19.0 |
| 16 | 0.5 | 5 | 7 | 12.5 |
| 17 | 3.0 | 5 | 7 | 15.0 |
| 18 | 4.0 | 7 | 8 | 19.0 |
| 19 | 0.5 | 5 | 8 | 13.5 |
| 20 | 4.0 | 6 | 8 | 18.0 |
| 21 | 0.5 | 6 | 9 | 15.5 |
| 22 | 1.0 | 6 | 9 | 16.0 |
| 23 | 1.0 | 6 | 9 | 16.0 |
| 24 | 1.0 | 6 | 10 | 17.0 |
| 25 | 1.0 | 5 | 7 | 13.0 |
| 26 | 2.0 | 5 | 7 | 14.0 |
| 27 | 1.0 | 4 | 11 | 16.0 |
| 28 | 1.0 | 7 | 9 | 17.0 |
| 29 | 2.0 | 8 | 11 | 21.0 |
| 30 | 1.0 | 5 | 9 | 15.0 |
| 31 | 0.5 | 7 | 7 | 14.5 |
| 32 | 3.0 | 5 | 7 | 15.0 |
| Minimum | 0.5 | 4 | 7 | 12.5 |
| Maximum | 4.0 | 9 | 11 | 21.0 |
| Average | 1.72 | 6.06 | 8.59 | 16.5 |

TABLE 3.—*Average duration of larval stadia or instars*

| Host | Date | Mean temperature | Number of cultures | Stadia in days | | | Larval period |
|---|---|---|---|---|---|---|---|
| | | | | First | Second | Third | |
| | | °*C.* | | | | | *Days* |
| Patola (*Luffa cylindrica*) | III–7 to IV–16–35 | 30.34 | 31 | 1.09 | 2.61 | 2.79 | 6.49 |
| Amargoso (*Momordica charantia*). | III–18 to IV–11–35 | 30.36 | 14 | 1.18 | 2.39 | 2.95 | 6.50 |
| Squash (*Cucurbita maxima*) | IV–2 to 11–35 | 29.07 | 6 | 1.00 | 2.83 | 2.83 | 6.66 |
| Upo (*Lagenaria leucantha*) | III–18 to IV–1–35 | 30.36 | 6 | 0.92 | 1.84 | 3.25 | 6.00 |
| Papaya (*Carica papaya*) | IV–2 to 7–35 | 29.15 | 3 | 1.00 | 1.67 | 2.33 | 5.00 |
| Average | | 29.85 | | 1.38 | 2.27 | 2.87 | 6.12 |

TABLE 4.—*Proportion of sexes of emerging adult melon flies*

| Culture number | Date of emergence | Number of males | Number of females |
|---|---|---|---|
| 1 | 9-II-35 | 17 | 19 |
| 2 | 20-II-35 | 46 | 40 |
| 3 | 21-II-35 | 46 | 35 |
| 4 | 22-II-35 | 11 | 14 |
| 5 | 23-II-35 | 11 | 23 |
| 6 | 24-II-35 | 5 | 3 |
| 7 | 28-II-35 | 48 | 67 |
| 8 | 15-III-35 | 11 | 13 |
| 9 | 18-III-35 | 6 | 13 |
| 10 | 20-III-35 | 27 | 26 |
| 11 | 24-III-35 | 26 | 17 |
| 12 | 26-III-35 | 5 | 12 |
| 13 | 28-III-35 | 22 | 22 |
| 14 | 28-III-35 | 70 | 75 |
| 15 | 29-III-35 | 50 | 28 |
| 16 | 20-IV-35 | 12 | 19 |
| 17 | 23-IV-35 | 20 | 28 |
| 18 | 29-IV-35 | 29 | 20 |
| 19 | 24-V-35 | 12 | 12 |
| 20 | 2-IX-35 | 50 | 42 |
| 21 | 22-X-35 | 12 | 15 |
| 22 | 23-X-35 | 23 | 39 |
| 23 | 23-X-35 | 18 | 26 |
| 24 | 25-X-35 | 32 | 53 |
| 25 | 5-XI-35 | 20 | 20 |
| 26 | 18-XI-35 | 4 | 10 |
| 27 | 19-XI-35 | 10 | 10 |
| 28 | 10-XII-35 | 11 | 9 |
| 29 | 23-XII-35 | 5 | 6 |
| 30 | 28-XII-35 | 9 | 19 |
| Average | | 22.3 | 24.5 |
| Sex ratio | | 0.4765 | 0.5237 |

TABLE 5.—*Pre-oviposition period and fecundity of female adult melon fly*

| Culture number | Pre-oviposition period | | | Period of fecundity | |
|---|---|---|---|---|---|
| | Emerged | Eggs laid | Days | Last laying | Days |
| 1 | 22–VII–32 | 11–VIII–32 | 20 | 3–X–32 | 53 |
| 2 | 22–VII–32 | 2–VIII–32 | 11 | 7–X–32 | 66 |
| 3 | 22–VII–32 | 9–VIII–32 | 18 | 16–X–32 | 68 |
| 4 | 23–VIII–32 | 1–VIII–32 | 9 | 9–XI–32 | 95 |
| 5 | 1–VIII–32 | 12–VIII–32 | 11 | 5–X–32 | 54 |
| 6 | 6–VIII–32 | 17–VIII–32 | 11 | 13–X–32 | 57 |
| 7 | 22–VIII–32 | 29–IX–32 | 7 | 9–X–32 | 41 |
| 8 | 23–VIII–32 | 5–IX–32 | 13 | 21–X–32 | 46 |
| 9 | 11–X–35 | 24–X–35 | 13 | 2–XII–35 | 39 |
| 10 | 22–X–35 | 5–XI–35 | 14 | 21–XII–35 | 46 |
| 11 | 23–X–35 | 7–XI–35 | 15 | 27–XII–35 | 50 |
| 12 | 23–X–35 | 14–XI–35 | 22 | 28–XII–35 | 44 |
| 13 | 24–X–35 | 13–XI–35 | 20 | 22–XII–35 | 39 |
| 14 | 24–X–35 | 11–XI–35 | 18 | 29–I–36 | 79 |
| 15 | 25–X–35 | 17–XI–35 | 23 | 13–I–36 | 57 |
| 16 | 28–X–35 | 16–XI–35 | 19 | 10–I–36 | 55 |
| 17 | 2–XI–35 | 19–XI–35 | 17 | 6–I–36 | 48 |
| 18 | 22–XI–35 | 18–XII–35 | 26 | 3–II–36 | 47 |
| 19 | 23–XI–35 | 14–XII–35 | 14 | 22–I–36 | 39 |
| 20 | 29–XI–35 | 16–XII–35 | 17 | 3–II–36 | 49 |
| Minimum | | | 7 | | 39 |
| Maximum | | | 26 | | 95 |
| Average | | | 15.9 | | 53.6 |

TABLE 6.—*Daily rate of oviposition* [a]

| Date of oviposition | Number of eggs deposited by fly | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 |
| VIII-1-32 | ------ | ------ | ------ | 26 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-2-32 | ------ | 10 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-6-32 | ------ | ------ | ------ | 11 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-8-32 | ------ | ------ | ------ | 5 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-9-32 | ------ | ------ | 30 | 40 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-10-32 | ------ | ------ | 3 | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-11-32 | 2 | ------ | 2 | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-12-32 | ------ | ------ | ------ | 9 | 1 | ------ | ------ | ------ | ------ | ------ |
| VIII-13-32 | ------ | 15 | 20 | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-14-32 | ------ | 7 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-15-32 | ------ | ------ | 21 | 30 | 16 | 45 | ------ | ------ | ------ | ------ |
| VIII-16-32 | ------ | ------ | ------ | 27 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-17-32 | ------ | ------ | 10 | 8 | ------ | 19 | 34 | ------ | ------ | ------ |
| VIII-18-32 | ------ | 10 | 22 | 12 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-19-32 | 19 | ------ | 8 | 21 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-20-32 | 22 | ------ | ------ | 9 | ------ | 1 | ------ | ------ | ------ | ------ |
| VIII-21-32 | ------ | ------ | ------ | 7 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-22-32 | ------ | ------ | ------ | 19 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-23-32 | 24 | ------ | 32 | 31 | 17 | ------ | 24 | ------ | ------ | ------ |
| VIII-24-32 | ------ | 11 | ------ | ------ | ------ | 26 | ------ | ------ | ------ | ------ |
| VIII-25-32 | ------ | ------ | 39 | 32 | ------ | ------ | ------ | ------ | ------ | ------ |
| VIII-26-32 | ------ | ------ | 5 | ------ | ------ | ------ | 12 | ------ | ------ | ------ |
| VIII-27-32 | ------ | ------ | ------ | 5 | ------ | 19 | ------ | ------ | ------ | ------ |
| VIII-28-32 | ------ | 7 | 7 | 5 | ------ | 9 | ------ | ------ | ------ | ------ |
| VIII-29-32 | 20 | ------ | ------ | 21 | ------ | 18 | 13 | ------ | 27 | ------ |
| VIII-30-32 | ------ | ------ | 19 | 2 | 18 | ------ | 7 | ------ | 5 | ------ |
| VIII-31-32 | ------ | ------ | 3 | 11 | ------ | 23 | 7 | ------ | ------ | ------ |
| IX-1-32 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | 31 | ------ |
| IX-2-32 | ------ | 17 | 7 | 3 | 1 | ------ | 22 | ------ | 25 | ------ |
| IX-3-32 | ------ | ------ | ------ | ------ | ------ | 12 | ------ | ------ | ------ | ------ |
| IX-4-32 | 21 | ------ | ------ | ------ | 6 | ([b]) | ------ | ------ | 36 | ------ |
| IX-5-32 | ------ | ------ | ------ | ------ | 25 | ------ | 30 | ------ | 30 | 13 |
| IX-6-32 | ------ | ------ | ------ | 19 | 18 | ------ | 38 | ------ | 27 | 4 |
| IX-7-32 | 28 | ------ | ------ | 18 | 12 | ------ | 9 | 18 | 31 | 14 |
| IX-8-32 | 10 | ------ | 30 | 2 | 10 | ------ | ------ | ------ | 26 | ------ |
| IX-9-32 | 31 | ------ | 10 | 40 | 41 | ------ | 16 | ------ | 43 | 35 |
| IX-10-32 | 5 | 7 | ------ | 28 | ------ | ------ | 5 | 7 | 5 | 8 |
| IX-11-32 | ------ | ------ | 30 | ------ | ------ | ------ | 22 | ------ | 27 | 27 |
| IX-12-32 | ------ | ------ | ------ | ------ | 22 | ------ | ------ | 6 | 25 | 36 |
| IX-13-32 | 10 | ------ | ------ | ------ | ------ | ------ | 6 | ------ | 20 | ------ |
| IX-14-32 | 11 | 8 | 9 | 8 | ------ | ------ | 8 | 2 | ------ | 29 |
| IX-15-32 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | 14 | 12 | 8 |
| IX-16-32 | ------ | ------ | ------ | ------ | ------ | ------ | 5 | 4 | ------ | ------ |
| IX-17-32 | ------ | ------ | 4 | ------ | ------ | ------ | 3 | 2 | 19 | ------ |

[a] Flies Nos. 1, 2, and 3 emerged July 22, 1932; No. 4, July 23; No. 5, August 1; No. 6, August 3; No. 7, August 6; No. 8, August 20; No. 9, August 22; and No. 10, August 23, 1932.

[b] Adult fly escaped.

TABLE 6.—*Daily rate of oviposition* [a]—Continued

| Date of oviposition | Number of eggs deposited by fly | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 |
| IX-18-32 | | | | | | | 10 | | | 28 |
| IX-19-32 | 10 | | | | | | | 6 | 4 | |
| IX-20-32 | | | 8 | | | | | 4 | | 1 |
| IX-21-32 | | | | | | | 1 | | | |
| IX-22-32 | | 4 | 23 | | | | 28 | 9 | 28 | 29 |
| IX-23-32 | 3 | | 2 | | | | 8 | 17 | 13 | 16 |
| IX-24-32 | 5 | | | 27 | | | | 5 | | 8 |
| IX-25-32 | | | 8 | | | | | | 14 | |
| IX-26-32 | | | | | | | 13 | | | 8 |
| IX-27-32 | | | | | 3 | | 1 | 12 | 10 | |
| IX-28-32 | 5 | | | | | | | (b) | | |
| IX-29-32 | | | | | | | | | | 5 |
| IX-30-32 | | | | | | | | | 5 | |
| X-1-32 | | | 1 | | | | | | 27 | |
| X-2-32 | | | 8 | | | | | | | |
| X-3-32 | 3 | 2 | | | | | 24 | | | 34 |
| X-4-32 | | | | | 5 | | | | | 19 |
| X-5-32 | | 13 | 1 | | 1 | | 18 | | | 8 |
| X-6-32 | 3 | | | | (c) | | | | 18 | 11 |
| X-7-32 | (c) | 3 | | | | | | | | |
| X-8-32 | | (c) | | 2 | | | | | | 2 |
| X-9-32 | | | | (c) | | | 3 | | | |
| X-10-32 | | | | | | | | | 2 | 15 |
| X-12-32 | | | | | | | | | | 15 |
| X-13-32 | | | | | | | c 2 | | | |
| X-14-32 | | | c 1 | | | | | | | |
| X-17-32 | | | | | | | | | | 17 |
| X-18-32 | | | | | | | | | 2 | |
| X-19-32 | | | | | | | | | | 8 |
| X-21-32 | | | | | | | | | | c 22 |
| X-26-32 | | | | | | | | | c 2 | |
| X-27-32 | | | | 3 | | | | | | |
| XI-3-32 | | | | 5 | | | | | | |
| XI-4-32 | | | | c 1 | | | | | | |
| Total | 232 | 114 | 363 | 461 | 196 | 172 | 369 | 126 | 494 | 420 |
| Minimum | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| Maximum | 31 | 15 | 39 | 40 | 41 | 45 | 38 | 18 | 43 | 36 |
| Average | 12 | 8 | 12 | 14 | 13 | 19 | 27 | 8 | 18 | 16 |

[a] Flies Nos. 1, 2, and 3 emerged July 22, 1932; No. 4, July 23; No. 5, August 1; No. 6, August 3; No. 7, August 6; No. 8, August 20; No. 9, August 22; and No. 10, August 23, 1932.

[b] Adult fly escaped.

[c] Adult fly died.

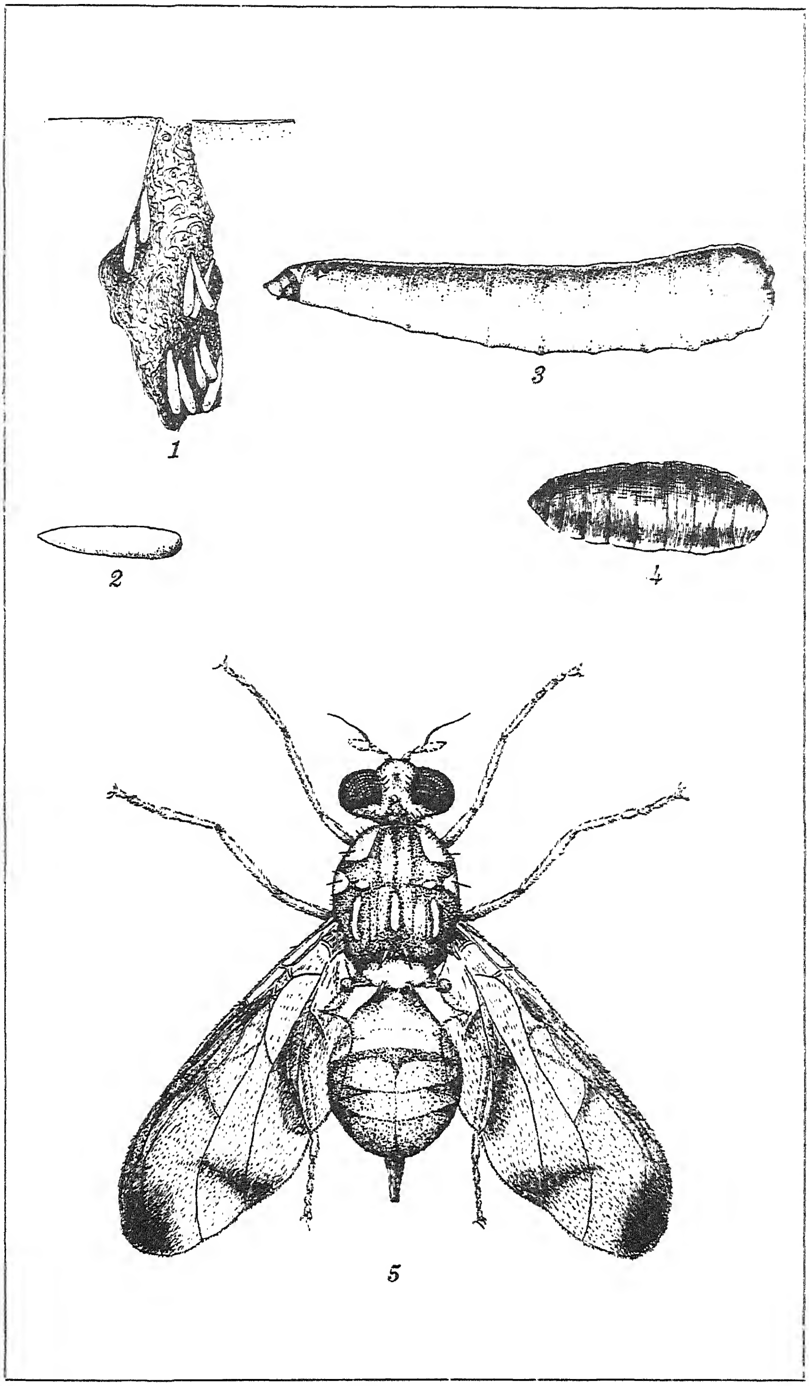
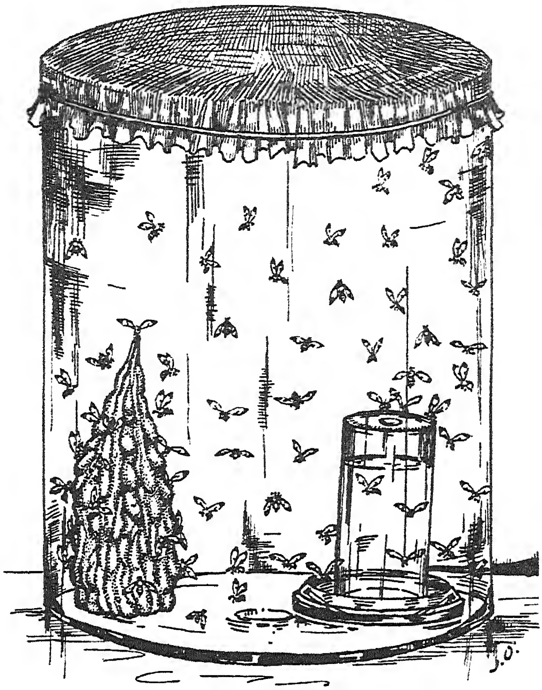
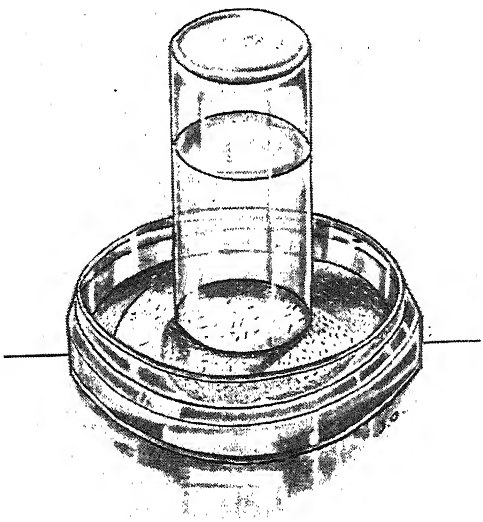



PLATE 1.



1



2

PLATE 2.

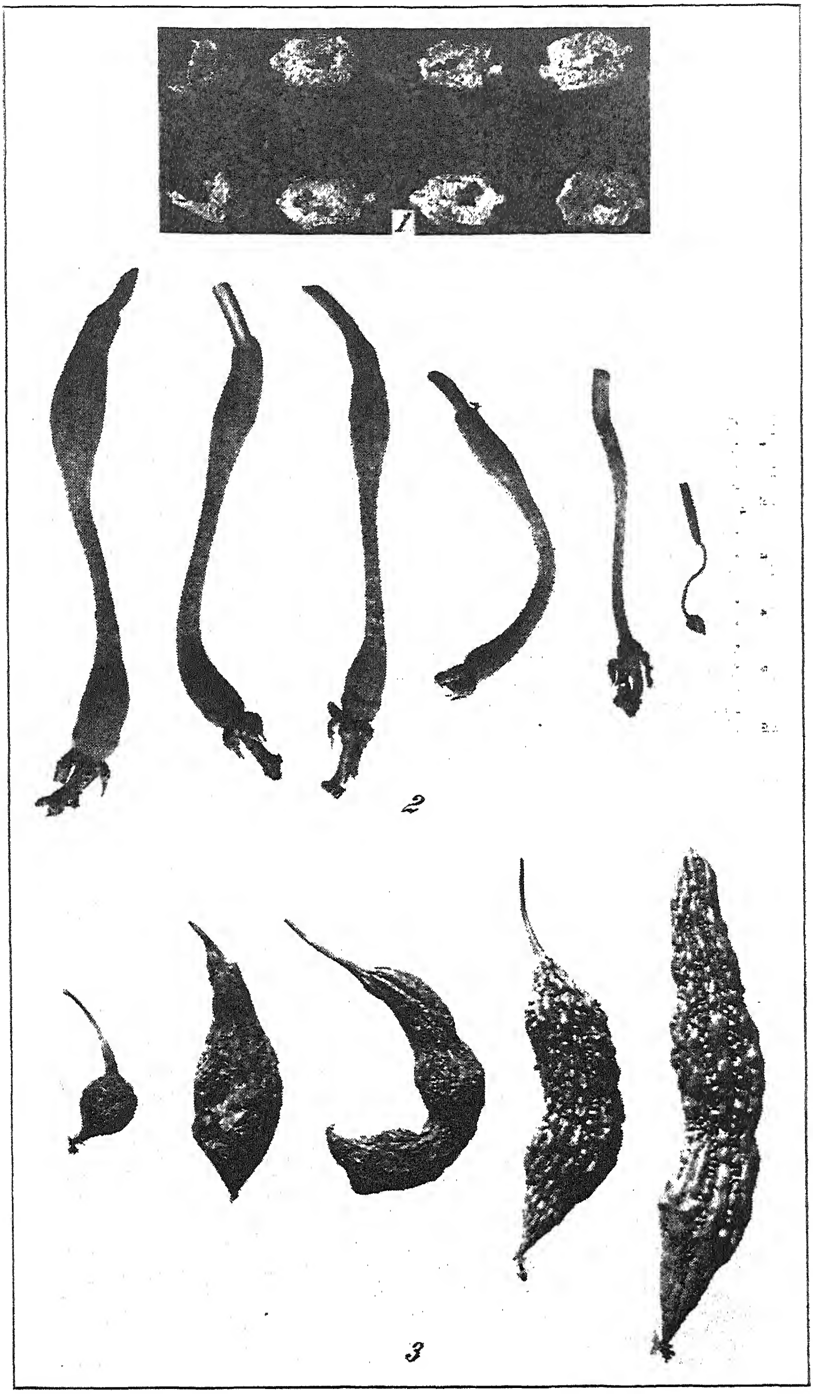



PLATE 3.

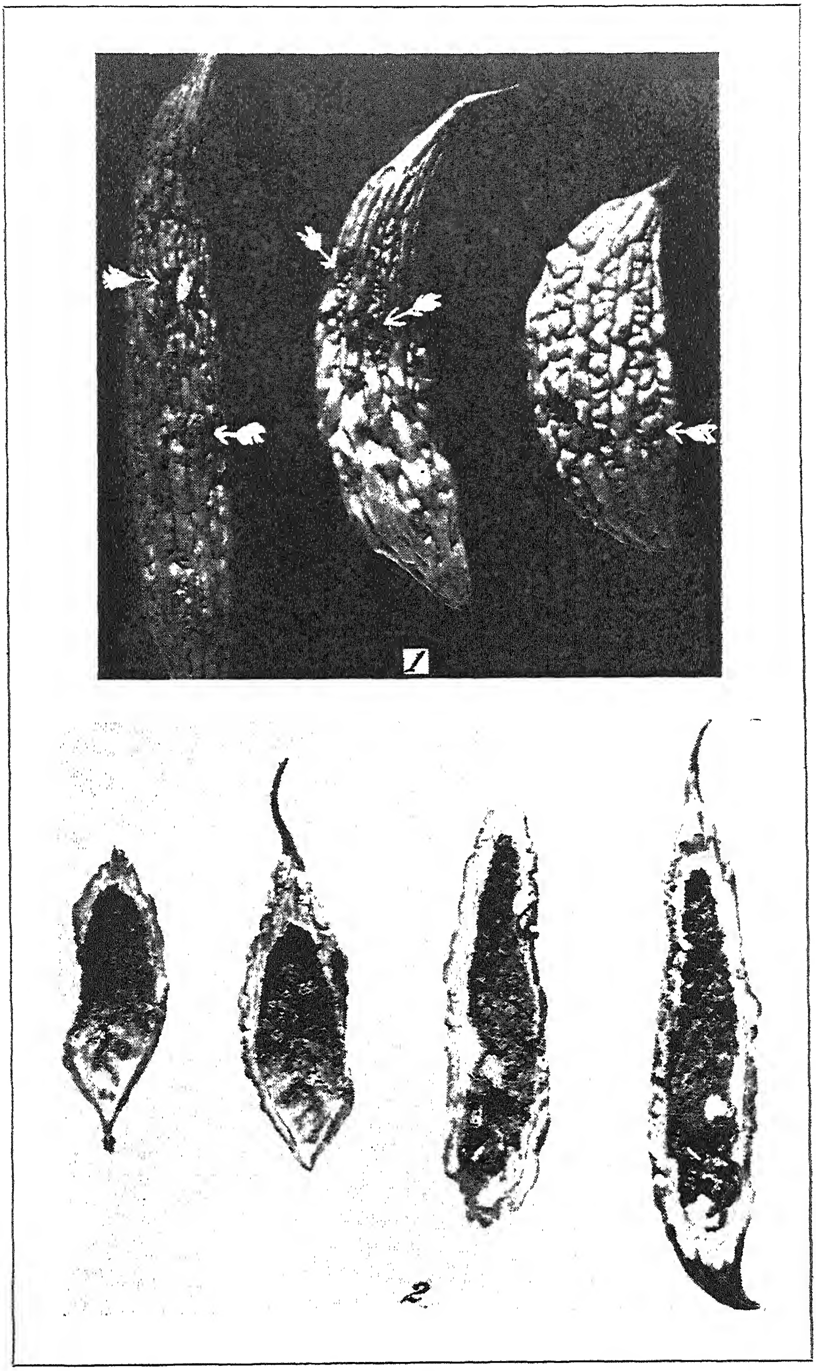



PLATE 4.

# THE ALUNAN CANE IN THE SUGAR INDUSTRY OF NEGROS

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and

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FIVE PLATES

## I. INTRODUCTION

Philippine cane seedling production, so far as the writers are aware of, began only in 1914 when a preliminary work was done at Alabang Stock Farm, then Alabang Experiment Station. This line of work was carried out realizing that not all imported canes thrived well in this country as in their places of origin.

At the Granja Sugar Cane Station (formerly La Carlota Sugar Cane Experiment Station), La Carlota, Occidental Negros, the first attempts at crossing work were made during the crop year 1922–23 and the actual extensive systematic breeding work was started only with the crop year 1924–25. Ever since that period thousands and thousands of cane seedlings were produced out of which only one outstanding strain (La Carlota 25/191) has been selected. It may be mentioned here in passing that this seedling cane has been the result of a tedious and patient work of the late Anselmo Labrador, then Agricultural Assistant of Granja Sugar Cane Station for a period of about 8 years. Up to the year 1932 the Alunan cane was called La Carlota 25/191 and sometimes simply La Carlota. Later, however, the name was changed to Alunan in honor of the then Secretary of Agriculture and Natural Resources, Hon. Rafael L. Alunan.

## II. PARENTAGE OF THE ALUNAN CANE

The Alunan cane is a product of a cross between Java 247 and the Badila which was performed during the crop year 1924–

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[a] The writers are grateful to Messrs. J. O. Unite and P. A. Honrado, of the Bureau of Plant Industry for reading and criticizing the manuscript.

25. This cross was made with the end in view of combining the desirable characteristics of Java 247 and Badila.

The parents of the Alunan cane have the following salient characteristics:

*Badila (New Guinea 15)*.—A cane introduced into the Philippines from Australia in 1912. Of high purity, usually erect in growth. Excellent in ratooning power. Quite resistant to mosaic and Fiji diseases, and highly resistant to smut. Fairly resistant to drought, though growth is of course retarded, giving oftentimes short internodes. This variety is suitable for fertile soils; medium maturing (12 to 14 months). Best harvested in December. Arrows freely in November and December but the points from canes that arrow can still be used as seeds.

Has erect to sometimes sub-erect habit of growth with 3 to 8 millable stalks per stool each from 0.98 to 1.74 (sometimes above 2) meters long, 2.5 to 4.5 centimeters in diameter, and each weighing 1.30 to 3.20 kilograms. Color of stalk, light purple to dark purple. Internodes, short very rarely medium in length; staggered; and tapering at one end (see Plate 2). Tissue, white and medium in texture. Epidermis cracks. Root band has sparse root dots arranged in three rows. Glaucous band heavily (although in some cases slightly) covered with bloom, and the color merges in that of the internodes. Buds large to sometimes medium in size, triangular (though in some instances orbicular), and usually developed on stalk.[1]

Leaves pale green, wide, coarse, relatively lanceolated in outline. Leaf sheaths with stiff deciduous hairs at back. Because of the stiff hairs and coarseness of leaves, same are not good for forage.

Badila has a relatively slow start in growth and therefore needs an early planting, not later than January; preferably earlier as in La Carlota, Isabela, Binalbagan, and Kabankalan districts (Occidental Negros). Because of slow growth, more cultivation is sometimes needed than other varieties that are fast growers.

Cheaper to harvest because of high quality ratio and because of the nature of the cane.

*Java 247 (Bouricious)*.—A cane introduced from Java. The plant is sub-erect with 5 to 10 millable stalks per stool each from 1.02 to 2.85 meters long, 1.8 to 3.5 centimeters in diameter

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[1] Juan O. Unite and Felix D. Maramba. Bureau of Plant Industry Contributions to Knowledge of Philippine Agriculture, 1931. Bureau of Printing, Manila, 1932, pp. 11–14.

and weighing 0.94 to 1.90 kilos. Stalks vinaceous purple, sometimes light green, light rose, tinged slightly red, light rose predominating. Internodes are long, slightly staggered and cylindrical in shape (see Plate 1). The tissue is white and quite hard in texture. Epidermis does not crack as much as that of the Badila. Root band has numerous root dots scattered indiscriminately. The glaucous band is heavily covered with bloom and the color blends with that of the internode.

Node not raised, internode narrow at middle; bud not well developed.

The buds are small, ovate, and dormant on the stalk.

The leaves are green, medium in width and broadly lanceolated in outline. The leaf sheaths are with deciduous stiff hairs on the back. Leaves are shed.

Arrows in November and December. Canes mature in 12 months. Like Badila, has excellent ratooning power. Slightly susceptible to mosaic but not to Fiji and smut diseases.

Has fairly low fiber content.[2]

## III. CHARACTERISTICS OF THE ALUNAN CANE

High purity cane, usually erect similar to Badila in growth. Excellent germinating and ratooning power. Fairly resistant to mosaic and Fiji diseases but highly resistant to smut. Fairly resistant to drought. Suitable to fertile soil like Badila, but grows fairly well in poor soil where other varieties could hardly grow. Cane mature in 12 to 14 months.

Has fairly erect and thrifty habit of growth with 5 to 12 millable stalks per stool each from 1.35 meters to 2.80 meters averaging about 2 meters; weighing from 1 to 2.4 kilos, averaging 1.8 kilos (see Plates 3 and 4). Stalks with much bloom merging all over on internodes.

Stalks, medium to large 3.5 to 4 centimeters in diameter; young stalks purplish to violet; mature ones, dirty purple. Internodes 9 centimeters to 16.5 centimeters averaging 12 centimeters long. Internal tissue solid, cream to brownish. Rind seem slightly harder than Badila and cracks less.

Root band, purplish white when young turning blood red or purplish violet when old; narrow to medium, slightly constricted, with 3 to 4 rows of root eyes scattered indiscriminately, usually 1 to 2 of upper rows remaining dormant.

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[2] Miscellaneous papers on Sugar Cane and Fertilizers. Bureau of Printing, Manila, 1929, pp. 18–25.

Growth ring medium to wide, slightly swollen.

Eye medium to broad, round to sometimes pointed, purplish white with purple rim from base to tip of bud when young, purple when old. Eye germination apical with nervature converting to top.

Joints straight, medium. Internodes fairly cylindrical and medium in length. Nodes narrow; smaller to almost even in diameter to internodes.

Leaf-scar straight, protruding below eye. Wax band conspicuous. Leaves medium to broadly lanceolated, green to light green, rough. Leaf sheath purplish to violet with light green intermingled, clasping tightly to stalk. Hair on back is light and stiff. Aërial roots quite plentiful and prominent.

The only seeming disadvantages of the canes are: (1) plentiful aërial roots as mentioned above, (2) dried leaves do not easily fall. Such characteristics give a slight trouble in harvesting.

## IV. PROPAGATION AND DISTRIBUTION OF THE ALUNAN CANE

The first commercial planting was made in 1928–29 by Mr. Luis Jalandoni, a planter of La Carlota district (Occidental Negros) who was the first to see the possibility of the strain. Its established fame began only in 1932–33 when in some haciendas the production reached even as high as 200 to 300 piculs where other varieties hardly reached 180 piculs.

The Alunan cane was distributed for the first time to the public by the Granja Sugar Cane Station in 1927, at first freely, but later a nominal price was charged. From that time, the distribution every year was as follows:

| Year | Number of points | Value |
|---|---|---|
| 1927 | 5,000 | [a] ₱25.00 |
| 1928 | 80,000 | [a] 400.00 |
| 1929 | 168,900 | 422.17 |
| 1930 | 323,900 | 809.75 |
| 1931 | 914,100 | 2,285.20 |
| 1932 | 285,600 | 713.95 |
| 1933 | 168,900 | 428.17 |
| 1934 | 483,000 | 1,167.50 |
| 1935 | 5,000 | [b] 10.00 |
| 1936 | 594,000 | 1,188.00 |
| Total | 3,028,400 | ₱7,449.74 |

[a] Free distribution. [b] Very limited amount for sale.

The following shows the crop years when the Alunan cane was introduced into the different central districts:

| | Crop year |
|---|---|
| 1. Palma | 1934–1935 |
| 2. San Isidro | 1933–1934 |
| 3. Bearin | 1933–1934 |
| 4. Binalbagan | 1931–1932 |
| 5. Isabela | 1931–1932 |
| 6. La Carlota | 1928–1929 |
| 7. Maao | 1929–1930 |
| 8. Lumañgub | 1932–1933 |
| 9. Bacolod–Murcia | 1932–1933 |
| 10. Talisay–Silay | 1932–1933 |
| 11. Hawaiian–Philippine | 1932–1933 |
| 12. Victorias Milling | 1931–1932 |
| 13. Manapla Central | 1931–1932 |
| 14. Lopez C. | 1931–1932 |
| 15. Leonor | 1933–1934 |
| 16. Danao | 1932–1933 |
| 17. San Carlos Milling | 1934–1935 |

## V. EXTENT OF CULTIVATION OF THE ALUNAN CANE AS COMPARED WITH OTHER COMMERCIALLY GROWN VARIETIES

For the past 8 to 10 years the per hectare production of the Philippines has been quite low, being less than 60 piculs per hectare. Much of this low yield has been attributed to the use of low yielding native canes. This, indeed, is true with many crops. In recent years, however, most of the canes in the Islands are the so-called new varieties. The POJ 2878, POJ 2883, LC 25/191 (Alunan), Badila, PSA 14, DI 52, Hawaii 109, and some few others are occupying the widest area under cultivation (see Table 1). Mention could be made in this connection that with the showing of the Alunan cane in the different districts especially in Occidental Negros, sooner or later this variety will occupy the widest acreage of all varieties presently grown in the Islands particularly in Negros Occidental. (See figure 1.) Although the commercial planting of Alunan began only in 1928, the variety has occupied a wide area beyond expectation due to its merit aided by the concerted efforts of the Bureau of Plant Industry particularly by the Granja Sugar Cane Station; aided by Dr. A. Gordon of La Carlota Central. (See Table 1.)

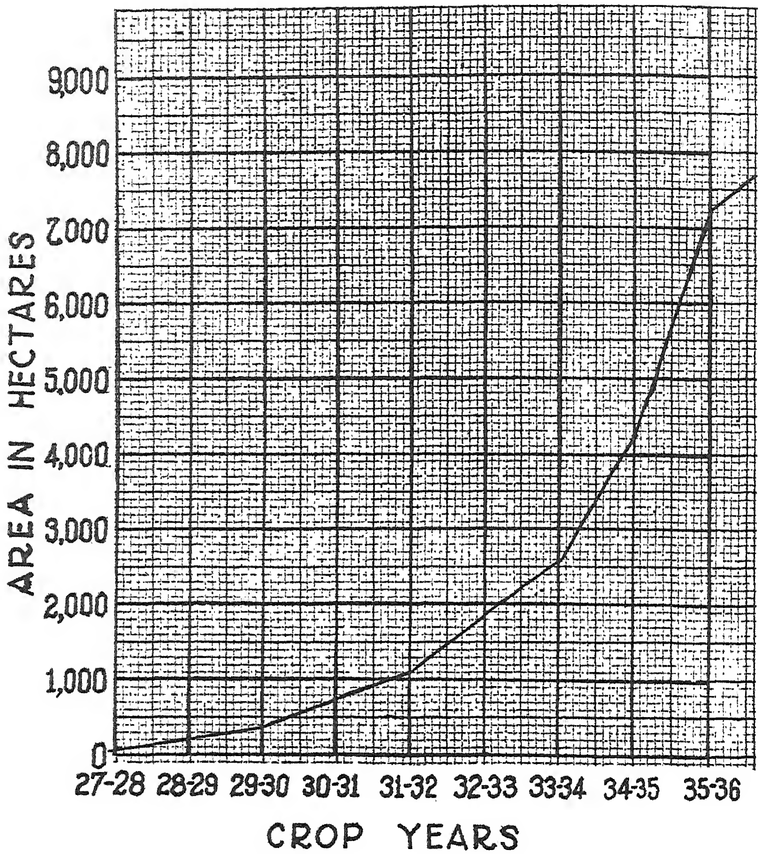


FIG. 1. Showing the trend of La Carlota 25/191 (Alunan) cane planting in Occidental Negros.

## VI. PERFORMANCE OF THE ALUNAN CANE AS COMPARED WITH OTHER COMMERCIALLY GROWN VARIETIES

It could be stated that in Occidental Negros, almost invariably, this cane has beaten all other grown varieties (see Tables 3, 4 and 5[3,4]). In the whole province of Negros Occidental the average tonnage of Alunan for the crop year 1935–36 was around

[3] Reports of chemists, assistant chemists, and chief cane inspector of some centrals.

[4] Alexander Gordon; Annual Report of the Dept. of Agri. and Expts., Central Azucarera de la Carlota, 1936.

TABLE 1.—*Showing the sugar cane acreage by varieties (in percentage) for the crop year 1936–1937 in the different districts*

| Central districts | Areas planted by varieties expressed in percentages | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | POJ 2878 | Badila | POJ 2883 | Alunan | DI 52 | Negros purple | Hawaii 109 | All others |
| | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Per cent* | *Per cent* |
| 1. San Carlos Milling Co. | 90 | 2 | 6 | 0.5 | ------- | ------- | 0.5 | 1 |
| 2. Danao Central | 50 | 25 | 20 | 2 | ------- | ------- | ------- | 3 |
| 3. Leonor Central | 48 | 25 | 12 | 1 | 2 | ------- | ------- | 12 |
| 4. Lopez Central | 38 | 25 | 8 | 8 | ------- | 2 | 7 | 12 |
| 5. Manapla Central | 59.12 | 21.52 | 8.22 | 6.63 | 0.54 | 1.69 | 1.13 | 2.15 |
| 6. Victorias Milling Co. | 57 | 23.5 | 8 | 6.5 | 1 | 1 | 1 | 2 |
| 7. Hawaiian Philippine | 50 | 18 | 15 | 5 | 5 | ------- | ------- | 7 |
| 8. Talisay-Silay | 45 | 30 | 12 | 7 | 1 | 2 | ------- | 3 |
| 9. Bacolod Murcia | 40 | 35 | 10 | 6 | 6 | ------- | ------- | 3 |
| 10. Hijos de la Rama | 28 | 36 | 5 | 6 | 20 | ------- | ------- | 5 |
| 11. Ma-ao Central | 23.1 | 42.7 | 2.9 | 6 | 20.7 | 1.5 | ------- | 3.1 |
| 12. La Carlota Central | 16 | 36 | 10 | 30 | 3 | 2 | ------- | 3 |
| 13. Isabela Central | 24 | 32 | 2.5 | 11.5 | 17 | 12.5 | ------- | 0.5 |
| 14. Binalbagan Central | 28 | 38 | 5 | 10 | 2 | 6 | ------- | 11 |
| 15. Bearin Central | 35 | 28 | 20 | 8 | 5 | 3 | ------- | 1 |
| 16. Palma Central | 30 | 29 | 20 | 8 | 4 | 6 | ------- | 3 |
| 17. San Isidro Central | 33 | 25 | 25 | 5 | 6 | ------- | ------- | 6 |
| 18. Muscovado Mills (3) | ------- | 30 | ------- | 3 | 20 | 42 | ------- | 5 |
| Total | 694.22 | 501.72 | 189.62 | 130.13 | 113.24 | 79.69 | 9.63 | 82.75 |
| Average | 38.57 | 27.87 | 10.53 | 7.23 | 6.29 | 4.43 | 0.54 | 4.60 |

NOTE.—The area planted to sugar cane for 1936–1937 is 108,189 hectares including those milled in the muscovado mills.

65 to 66 tons with a quality ratio of 2 piculs per ton cane. An average of around 135 piculs per hectare was registered in the whole province as compared with 115 piculs or less for the other varieties (see Tables 2, 3, 4 and 5). With the area of 7,196 hectares (only in Occidental Negros) for the 1935–36 crop year, this cane yielded about 935,480 piculs, and with the average price of about ₱8 a picul for the year, it gave the province a gross sale of around ₱7,483,840. For the crop year 1936–37 the area covered with the Alunan cane reached over 7,822 hectares in the above-mentioned province.

Mr. Jose Gaton, assistant chemist of Manapla Central, communicating with one of the writers on December 3, 1936, says; "The Alunan cane is doing pretty well in the district (Manapla Central district). There is every probability that a greater portion of the plantations will be planted with this variety in the near future". According to him the Company's records of the

TABLE 2.—*Showing the performance of Alunan cane as compared with other standard varieties*

| Centrals | 1931–32 | | | 1932–33 | | | 1933–34 | | | 1934–35 | | | 1935–36 | | | Average | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tons cane per hectare | Purity | Piculs sugar per hectare | Tons cane per hectare | Purity | Piculs sugar per hectare | Tons cane per hectare | Purity | Piculs sugar per hectare | Tons cane per hectare | Purity | Piculs sugar per hectare | Tons cane per hectare | Purity | Piculs sugar per hectare | Tons cane per hectare | Purity | Piculs sugar per hectare |
| 1. San Isidro [a]: | | | | | | | | | | | | | | | | | | |
| Alunan | ---- | ---- | ---- | ---- | ---- | ---- | 80 | 88 | 160 | 70 | 85 | 120 | 60 | 86 | 120 | 70 | 86.3 | 133.3 |
| POJ 2878 | 60 | 83 | 100 | 65 | 81 | 100 | 65 | 81 | 100 | 60 | 80 | 90 | 56 | 81.8 | 90 | 61.2 | 81.4 | 96 |
| POJ 2883 | 93 | 82 | 150 | 90 | 81 | 135 | 90 | 81 | 135 | 65 | 80 | 100 | 56 | 81.8 | 90 | 78.8 | 81.2 | 122 |
| Badila | 65 | 88 | 120 | 55 | 85 | 100 | 55 | 85 | 100 | 63 | 82 | 100 | 55 | 82 | 100 | 58.6 | 84.4 | 104 |
| Negros Purple | 33 | 85 | 60 | 35 | 83 | 60 | 33 | 84 | 60 | ---- | ---- | ---- | 43 | 81 | 70 | 36 | 83.3 | 62.5 |
| DI–52 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 40 | 86 | 80 | 40 | 86 | 80 |
| 2. Palma [b]: | | | | | | | | | | | | | | | | | | |
| Alunan | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 90 | 88.11 | 160 | 72 | 86.2 | 120 | 81 | 87.2 | 140 |
| POJ 2878 | 60 | 82 | 90 | 60 | 82 | 90 | 60 | 82 | 90 | 60 | 82 | 90 | 68 | 85.05 | 100 | 61.6 | 82.6 | 92 |
| POJ 2883 | 90 | 85 | 140 | 90 | 85 | 140 | 90 | 85 | 140 | 90 | 85 | 140 | 75 | 87.10 | 125 | 87 | 85.4 | 137 |
| Badila | 50 | 87 | 90 | 50 | 87 | 90 | 50 | 87 | 90 | 50 | 87 | 90 | 65 | 86.5 | 100 | 53 | 86.9 | 92 |
| Negros Purple | 50 | 87 | 80 | 50 | 87 | 80 | 50 | 87 | 80 | 50 | 87 | 80 | 50 | 84.15 | 90 | 50 | 86.2 | 82 |
| DI–52 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 50 | 85.04 | 95 | 50 | 85 | 95 |
| 3. Bearin [b]: | | | | | | | | | | | | | | | | | | |
| Alunan | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 73 | 86.15 | 100 | 73 | 86.15 | 100 |
| POJ 2878 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 68 | 84.30 | 95 | 68 | 84.30 | 95 |
| POJ 2883 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 72 | 86.10 | 100 | 72 | 86.1 | 100 |
| Badila | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 65 | 86.11 | 90 | 65 | 86.11 | 90 |
| Negros Purple | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 58 | 84.15 | 95 | 58 | 84.15 | 95 |
| DI–52 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 50 | 84.06 | 90 | 50 | 84.06 | 90 |
| 4. Binalbagan [a]: | | | | | | | | | | | | | | | | | | |
| Alunan | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 75 | 87.12 | 125 | 75 | 87.12 | 125 |
| POJ 2878 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 65 | 84.72 | 100 | 65 | 84.72 | 100 |
| POJ 2883 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 75 | 85.18 | 120 | 75 | 85.18 | 120 |
| Badila | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 70 | 87 | 100 | 70 | 87 | 100 |
| Negros Purple | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 58 | 84 | 95 | 58 | 84 | 95 |
| DI–52 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 53 | 81 | 80 | 53 | 81 | 80 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5. Isabela [c]: | | | | | | | | | | | | | | | | | | |
| Alunan | | | | | | | | | | | | | 57 | 88.66 | 117 | 57 | 88.66 | 117 |
| POJ 2878 | | | | | | | | | | | | | 52 | 86.34 | 98 | 52 | 86.34 | 98 |
| POJ 2883 | | | | | | | | | | | | | 60 | 85.91 | 109 | 60 | 85.91 | 109 |
| Badila | | | | | | | | | | | | | 44 | 87.54 | 88 | 44 | 87.54 | 88 |
| Negros Purple | | | | | | | | | | | | | 36 | 86.70 | 67 | 36 | 86.70 | 67 |
| DI-52 | | | | | | | | | | | | | 42 | 89.07 | 86 | 42 | 89.07 | 86 |
| 6. Manapla [b] (only at Hacienda of Centrals): | | | | | | | | | | | | | | | | | | |
| Alunan | | | | | | | | | | | | | 64.44 | | 172 | 64.44 | | 172 |
| POJ 2878 | | | | | | | | | | | | | 51.45 | | 95 | 51.45 | | 95 |
| POJ 2883 | | | | | | | | | | | | | 62.81 | | 105 | 62.81 | | 105 |
| Badila | | | | | | | | | | | | | 53 | | 102 | 53 | | 102 |
| Negros Purple | | | | | | | | | | | | | 53 | | 92 | 53 | | 92 |
| DI-52 | | | | | | | | | | | | | 52 | | 94 | 52 | | 94 |
| Hawaii 109 | | | | | | | | | | | | | 53 | | 90 | 53 | | 90 |
| 7. Hacienda Carmiña [d] (Sagay-Escalante District): | | | | | | | | | | | | | | | | | | |
| Alunan | | | | | | | | | | | | | 83.17 | 88 | 180 | 83.17 | 88 | 180 |
| POJ 2878 | | | | | | | | | | | | | 85 | | 150 | 85 | | 150 |
| POJ 2883 | | | | | | | | | | | | | 83 | | 155 | 83 | | 155 |
| Badila | | | | | | | | | | | | | 65 | | 108 | 65 | | 108 |

[a] Data furnished by Chief Chemists of Centrals.
[b] Data furnished by Assistant Chemists of Centrals.
[c] Data furnished by the Chief Cane Inspector.
[d] Data furnished by Manager of Hacienda.

performances of the cane (only Company's haciendas where records are available) are as follows:

| Crop year | | Production per hectare |
|---|---|---|
| | | *Piculs* |
| 1933–1934 | | 145.71 |
| 1934–1935 | | 152.16 |
| 1935–1936 | | 172.71 |
| 1936–1937 | (approximately) | 179.46 |

In the report of Dr. A. Gordon of the La Carlota Sugar Central in 1934 he said, "The rapid rise to popularity of variety Alunan which was developed at the La Carlota Sugar Cane Experiment Station from Badila and Java 247 parents has the support of results from variety tests carried out in this district. During this milling season this variety has acquitted itself well in juice qualities and farm returns. This has been fairly heavy tonnage yielding variety and our planters are over-enthusiastic, to say the least." Again, in his 1936 report, he says, "The Alunan cane is now the pet variety in this district (La Carlota) and it is not much to expect that this will be known only through its merit in this district". . .

"The variety Alunan (LC 25/191) has caught the fancy of our planters in this district. The results to date have been gratifying. Its popularity has made it our standard variety for the district."

"The juice analysis of Alunan has been quite steady for sometime now . . . Alunan is now about 30 per cent of the cane crop of La Carlota district." Tables 4 and 5 of Doctor Gordon's annual report are here reproduced showing the performances of the standard varieties in the district of La Carlota.

As could be seen in Table 2, the showing of the variety is indeed heartening in all the districts of the province. The crop years 1935–1936 and that of the present tended more and more to point to the supremacy of the cane—at least as compared to the other standard varieties presently being grown in the province.

The piculs of sugar yield per hectare goes in favor of Alunan for plant canes while in the ratoon POJ 2883 beats the other varieties but is closely followed by the Alunan cane.

TABLE 3.—*Summary results of experiments at Hacienda Parnaso* [a]

| Varieties | Crop | Number of replications | Crusher juice | | | Yield per hectare | | Piculs sugar per ton cane |
|---|---|---|---|---|---|---|---|---|
| | | | Brix | Polarization | Purity | Tons cane | Piculs sugar | |
| Alunan | Plant | 10 | 19.8 | 18.2 | 91.9 | 62.30 | 138.14 | 2.22 |
| | Ratoon | 10 | 17.6 | 15.4 | 87.0 | 82.45 | 147.63 | 1.79 |
| Totals and averages | | | 18.5 | 16.6 | 89.1 | 144.75 | 285.77 | 1.98 |
| POJ 2883 | Plant | 10 | 17.8 | 15.3 | 85.8 | 66.12 | 116.22 | 1.76 |
| | Ratoon | 10 | 17.9 | 14.8 | 82.7 | 97.79 | 159.14 | 1.63 |
| Totals and averages | | | 17.9 | 15.0 | 84.0 | 163.91 | 275.36 | 1.68 |
| POJ 2878 | Plant | 10 | 17.7 | 14.9 | 84.2 | 45.68 | 76.58 | 1.67 |
| | Ratoon | 10 | 17.5 | 14.7 | 83.5 | 88.36 | 144.47 | 1.64 |
| Totals and averages | | | 17.6 | 14.8 | 83.7 | 134.04 | 221.05 | 1.65 |
| Badila | Plant | 10 | 20.3 | 18.3 | 90.0 | 46.48 | 101.92 | 2.20 |
| | Ratoon | 10 | 18.3 | 15.6 | 85.1 | 86.48 | 153.19 | 1.78 |
| Totals and averages | | | 19.0 | 16.5 | 86.8 | 132.96 | 255.11 | 1.91 |

TABLE 4.—*Showing averages of yields of five commercially grown varieties in the La Carlota district* [a]

| Varieties | Number of tests | Averages from results of variety tests | | | | | |
|---|---|---|---|---|---|---|---|
| | | Tons cane per hectare | | Piculs sugar per hectare | | Piculs sugar per ton cane | |
| | | Plant | Ratoon | Plant | Ratoon | Plant | Ratoon |
| Alunan | 16– 8 | 82.94±3.74 | 65.25±3.63 | 159.88±6.01 | 130.28±4.97 | 1.96±.04 | 2.03±.05 |
| Badila | 22–18 | 70.13±2.57 | 54.57±2.10 | 130.51±4.09 | 106.02±3.00 | 1.90±.04 | 1.97±.03 |
| DI-52 | 6– 5 | 71.78±2.45 | 56.98±2.91 | 153.55±6.18 | 114.72±3.85 | 2.14±.04 | 1.75±.07 |
| POJ 2878 | 23–15 | 84.06±2.88 | 72.53±2.43 | 136.17±4.91 | 125.22±3.73 | 1.65±.05 | 1.75±.04 |
| POJ 2883 | 14– 7 | 91.56±4.66 | 85.29±3.97 | 151.26±7.57 | 150.79±5.30 | 1.68±.05 | 1.79±.04 |

[a] Results obtained by Dr. Alexander Gordon of Central Azucarera de La Carlota.

TABLE 5.—*Comparative performances of the commercially grown sugar-cane varieties at the Granja sugar-cane Station*

VARIETY TEST OF 3 VARIETIES (PLANT CANE) IN 1929–30

| Varieties | Brix C. J. | Polarization C. J. | Purity C. J. | Piculs per ton cane | Tons cane per hectare | Piculs sugar per hectare |
|---|---|---|---|---|---|---|
| 1. Alunan (LC 25/191) | 18.57 | 16.70 | 89.90 | 2.05 | 74.39 | 152.50 |
| 2. DI–52 | 18.53 | 16.70 | 90.10 | 2.06 | 64.69 | 133.26 |
| 3. Negros Purple | 16.83 | 14.23 | 84.40 | 1.68 | 60.62 | 101.84 |

RESULTS OF THE 1932–33 AND 1933–34 CROP YEARS UNDER ACTUAL COMMERCIAL PLANTING

| Varieties | Tons cane per hectare | Piculs sugar per ton cane | Piculs sugar per hectare |
|---|---|---|---|
| 1932–33 | | | |
| 1. Alunan (LC 25/191) [3] | 100.14 | 1.67 | 167.23 |
| 2. DI–52 (plant cane) [1] | 86.73 | 1.62 | 140.50 |
| 3. Labrador (plant cane) [1] | 80.49 | 1.67 | 134.42 |
| 4. Badila (1st. ratoon) [1] | 76.77 | 1.76 | 135.12 |
| 5. POJ 2878 (plant cane) [1] | 71.3 | 1.45 | 103.39 |
| 6. Barbados 147 (plant cane) [1] | 62.39 | 1.66 | 103.57 |
| 1933–34 | | | |
| 1. Alunan (LC 25/191) [3] | 85.28 | 2.165 | 184.63 |
| 2. PSA 14 [2] | 86.56 | 1.98 | 173.39 |
| 3. POJ 2883 (plant cane) [1] | 78.295 | 2.26 | 176.95 |
| 4. Badila (2nd. ratoon) [1] | 72.00 | 2.28 | 164.16 |
| 5. DI–52 (ratoon) [1] | 62.86 | 2.32 | 145.84 |

[1] Data on one field of 3 hectares.
[2] Data on one field of 1 hectare in a relatively newly opened field.
[3] Averages of 3 fields of both ratoons and plant canes.

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# ILLUSTRATIONS

PLATE 1.

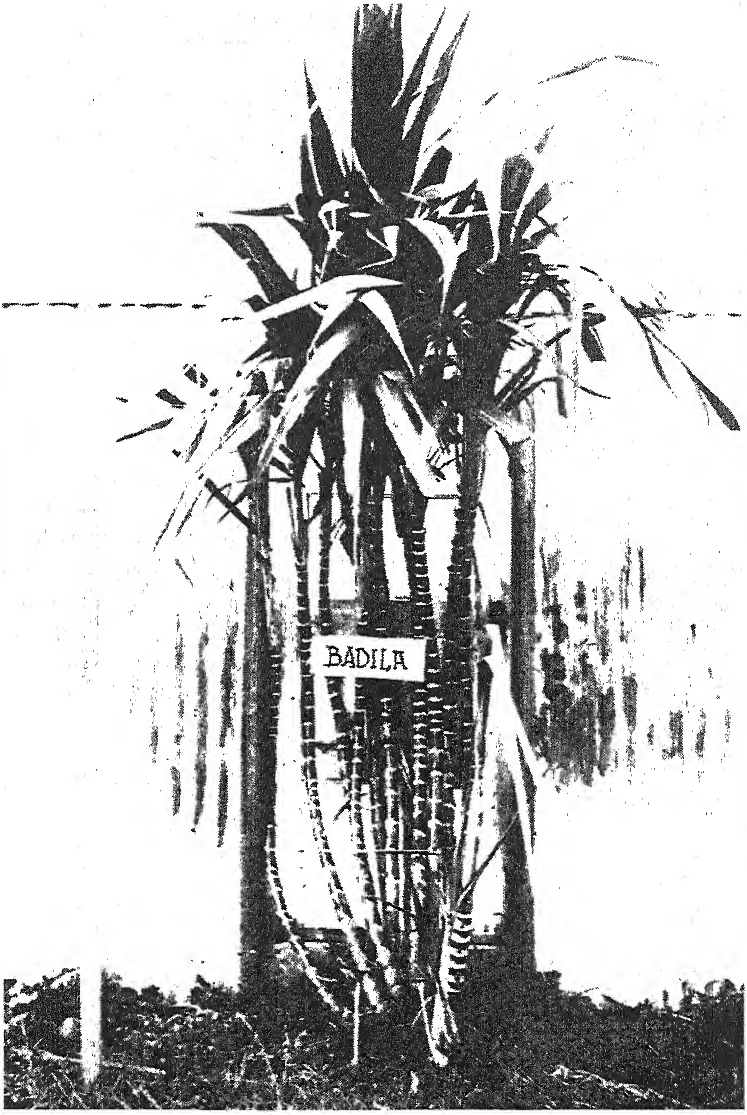


PLATE 2.

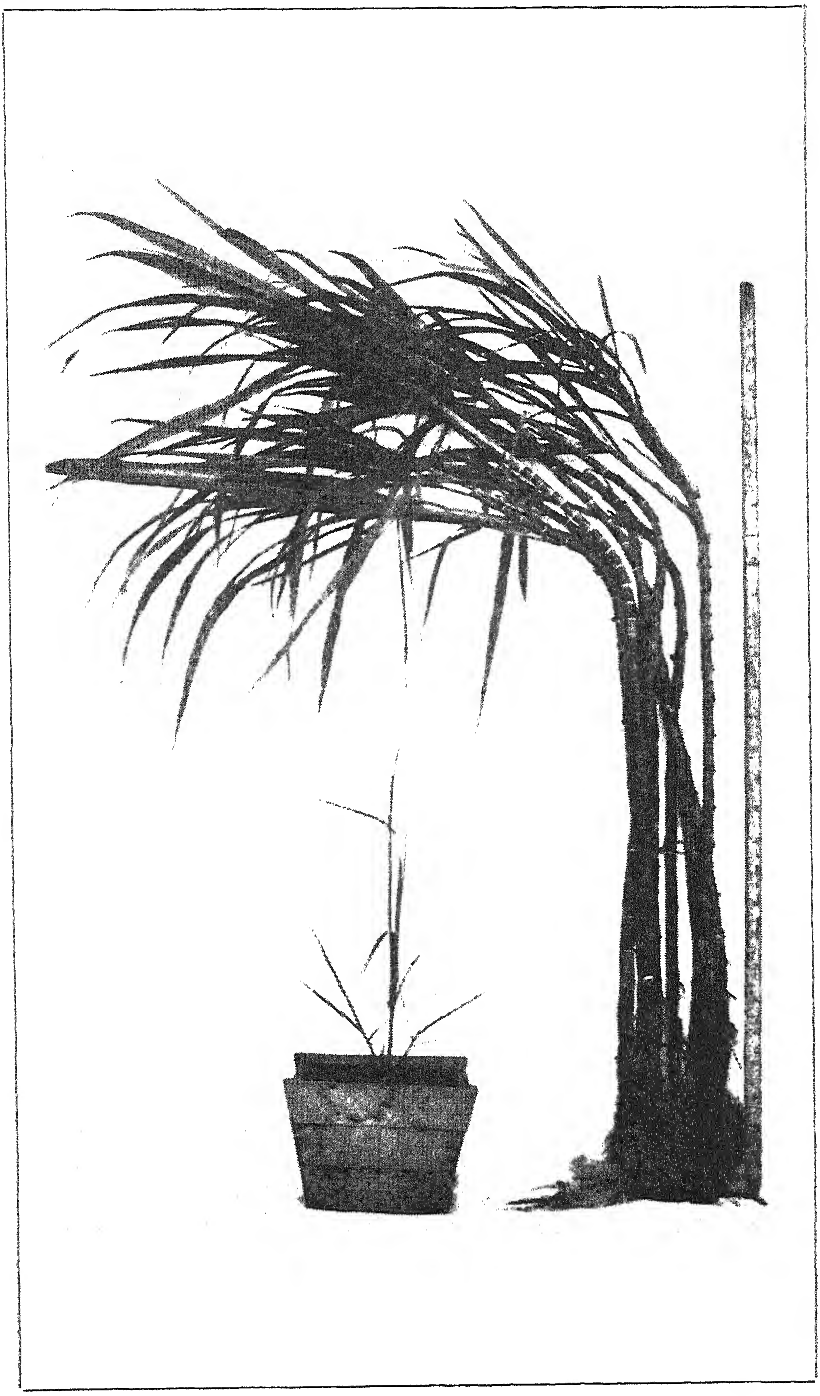

PLATE 3.

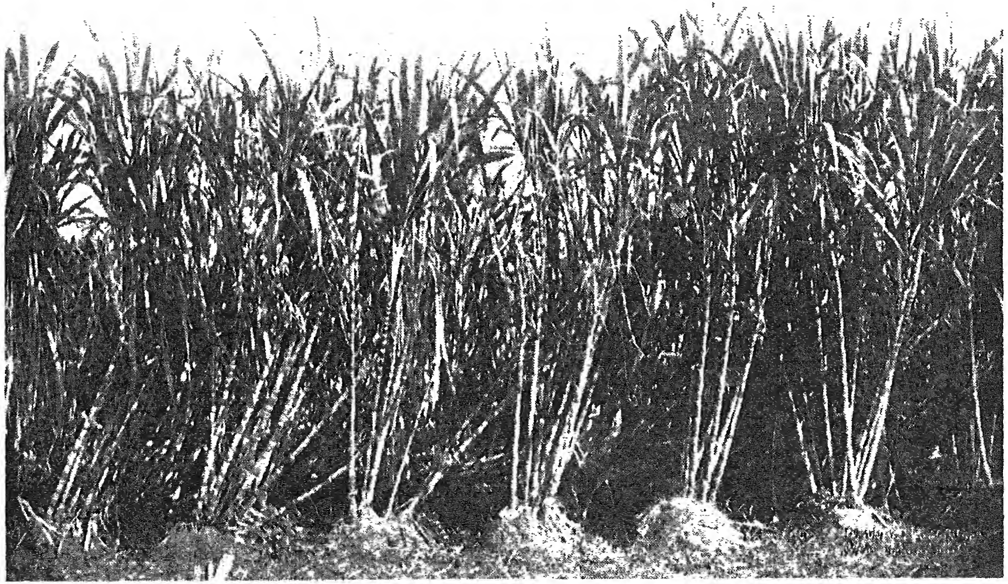

PLATE 4.

PLATE 5.

# PROGRESS REPORT ON REGIONAL ADAPTATION STUDY ON THE PRODUCTION OF CIGAR-WRAPPER LEAF TOBACCO UNDER OPEN CONDITION IN THE PHILIPPINES

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FOUR PLATES

The practice of constructing suitable shades over tobacco plantations in Luzon for the purpose of producing cigar-wrapper leaf of fine-grade involves prohibitive expense, that it is not followed in a big scale. This is especially true when the farmer has a limited amount of capital to invest in cigar-wrapper production. The object of looking for a region or regions where high-grade cigar-wrappers can be grown under open condition is therefore obvious, hence this study reported in this paper.

Trial plantings of the wrapper type of tobacco (Ilagan Sumatra) was conducted at the Davao Penal Colony; at Los Baños Economic Garden, Los Baños, Laguna; and at the Central Experiment Station, Manila during the 1934–1935 tobacco season. The harvest obtained from this preliminary planting showed encouraging results in favor of the Davao Penal Colony products. The planting of tobacco was therefore repeated at Davao Penal Colony only during the 1935–1936 tobacco season and the experiment was conducted under the immediate supervision of the last author.

Using Gutierrez's(1 and 2) finding in Cotabato Valley as a guide as to the best time of the year to plant tobacco and of Gutierrez(2) and Paguirigan(3) for proper distancing of open grown cigar-wrapper leaf tobacco, the author grew tobacco plants in Davao Penal Colony from November, 1935 to April, 1936. The distance of planting used was 50 cm. between the hills and the rows were set at 50 and 80 cm. apart alternately.

## SOIL AND CLIMATE

The field selected was newly cleared. The soil is clay loam, deep, friable and rich in humus. The field was traversed by a creek and well drained.

*Harvesting.*—The first flower to appear was noticed 46 days after transplanting. Because the curing shed was not yet ready at that time priming was delayed 4 days, Plate I. The first harvest was made on February 26, 1936. The successive priming of the leaves were taken on March 7, 16, 22, 30 and April 6, 1936. Harvesting the leaves was done only during the latter part of the day when the leaves were free from moisture. Harvested leaves were brought to the curing shed to be poled. The leaves were strung "back to back" and "face to face" with the use of rattan cords ranging in number, from 50 to 60 leaves per cord. Each end of the cord was tied to a pole about 1½ meters long and then hung on the racks to cure.

*Curing shed.*—The curing shed was made of light materials as bamboo and rattan leaves, Plate II. It measured 14 meters long 8 meters wide and 4 meters high. The shutters were made of rattan leaves. On account of the material used, close fitting of the windows and doors were not possible.

The racks were arranged lengthwise in the curing shed. An ample space was provided for at the middle of the shed for aisle. There were seven layers of racks in each division and spaced 50 cm. apart. The placing of poled leaves to be cured was started from the lower most layer upward. This was followed until all the racks of the first half of the curing shed was filled, after which the same procedure was followed on the other half.

The windows and doors of the curing shed were usually opened between eight and nine o'clock in the morning and were closed at about 4.30 o'clock in the afternoon. Blazers were not used except in one instance when the humidity of the air in the curing shed was too high due to heavy rainfall which lasted one whole day. Under Davao Penal Colony condition and with the kind of curing shed constructed (Plate II) tobacco leaves were cured completely within 26 days after stringing.

*Fermentation.*—Cured tobacco leaves were immediately put down from the racks and built into small "mandalas." When all the tobacco leaves were cured, the small "mandalas" were put together and a big mandala was built in one of the corners of the curing shed, measuring 8 feet long and 4 feet wide. The maximum temperature recorded after two rebuildings of the mandala was 50° C.

## DISCUSSION OF RESULTS AND OBSERVATIONS

The results of this study are presented under two headings. The prevalence of pests and diseases in Davao Penal Colony are taken first and the growth of the tobacco plants and quality of the leaf produced, are discussed next.

### PEST AND DISEASES

The tobacco insect pests encountered during the season were the cut-worms, leaf folder, stem borer, bugs and some leaf eating insects.

*Cut-worms.*—The cut-worms consisted of caterpillars of *Prodenia litura* and *Chloridea assulta,* both belonging to the family Noctuidæ. Both insects were persistent in their attack, starting from the seed beds up to the harvesting period, while the caterpillars of *Prodenia* have extended their damages up to the curing house. Both of them, however, were effectively controlled by persistent hand picking supplemented by dusting, using the arsenate of calcium mixed with "gawgaw". A predator, belonging to the genus *Harpactor,* was in abundance in the field and undoubtedly it had helped, to a certain extent, in the control of the caterpillars. This predator was observed feeding upon newly hatched larvae.

*Leaf-folder.*—Leaf folder was observed in the seed beds but its progress was checked by hand picking, supplemented by light dusting with calcium arsenate.

*Stem-borer.*—The tobacco stem borer was observed attacking the newly transplanted plants which were recovering. Its further damage, however, was checked by destroying infested plants including the worm inside the stem and replanting the hills with vigorous and stocky seedlings. The tobacco bug and some leaf-eating insects, like the tobacco *green cricket* and the *katytid,* were not attended to as their attack was not serious. They were either controlled by hand picking or dusting with calcium arsenate and "gawgaw" mixture.

### DISEASES

Among the tobacco diseases that were encountered during the season were damping off, mosaic, frog-eye spot, midrib-rot, and green-leaf spot.

*Damping off.*—This disease appeared only in the seed beds. It was effectively checked by exposing the seedlings to direct

sunshine in the morning, removing the infected seedlings including the soil and filling the hole with new one, regulating the watering of seed beds in order not to allow the rapid growth of the fungus especially during the night, and thinning the seedlings in order to give more aëration.

*Mosaic.*—This disease was first noticed when the young plants have just recovered. Since replanting was still advisable, all affected plants were removed and were replaced by healthy seedlings. With this method, the disease was checked. However, during the blooming period the disease appeared again but at this time only the top leaves and the suckers were affected. No effort to control the disease was made.

*Frog-eye spot.*—Frog-eye spot appeared during the latter part of the season. It was not so serious as to warrant any attention to control it. Nevertheless the leaves harboring the spots were removed as a precaution.

*Midrib-rot.*—The prevalence of midrib-rot was first observed among the unharvested leaves in the field. This was about the middle part of March, 1936. The fungus causing the disease attacked the midribs and veins of the leaves. It also attacked the main stem of the plant entering through the leaf scar. There were only few plants that toppled on account of this disease. Its presence in the plantation is easily detected by the dropping condition of the leaves of infected plants, Plate III, the leaves of whole plant appearing as if wilting. Close examination of plants attacked with this disease had black leaves and soft midribs. The fungus causing this particular disease easily spreads to normal leaves, especially to fresh ones in the curing shed. Care was therefore taken not to bring infected leaves to the curing house. All infected leaves or even the whole plant were gathered and discarded in order to prevent the spread of the fungus.

*Tobacco Green-leaf spot.*—This malady is gaining importance in all regions of the Philippines raising cigar-wrapper leaf tobacco. The results of the study of Paguirigan *et al.*(4) on the causes of the green-leaf spot corroborates the observations made at the Davao Penal Colony during the trial plantings. Some of the results of their study are quoted:

1. Green-leaf spot occurs all over the Philippines regardless of the type of soil and condition of climate in which the leaf wrapper type is grown. Tobacco plants that are grown under shade of abacá cloth develop green leaf spots easily.

2. The severity of the occurrence of green-leaf spot is directly correlated with the structure of the leaf. It occurs more on the leaves of shaded plants, or plants growing in places with very high humidity.
3. Extremes of weather conditions during the curing process favor the production of green-leaf spot, the shaded leaves being the ones affected most.
4. The primordial cause of green-leaf spot is most likely not pathogenic, but the disturbances of the physiological functions of the cells which are cut short due to premature death of the cells on account of extremes of temperature, abundance of moisture, lack of air, or rapid dehydration of the protoplasm.

In addition to the above findings, it was observed in this study that the age of the leaf when harvested played an important factor in the appearance of the green-leaf spot. Immature leaves besides having undesirable color for wrapper purposes were observed to produce green-leaf spot more readily than leaves harvested at medium age. Leaves at the right stage for harvesting cigar-wrapper leaf tobacco may be detected by the following symptoms: (a) Slight change of leaf texture from pliant to tough, (b) Slight change of color shade of leaf from "live" or dark green to pale green and (c) Slight yellowing of leaf tips and margins.

### THE PLANT

The stand of the tobacco plants in the plantation was very uniform as is seen in Plate I. The plants were healthy, stocky and relatively tall, Plate IV. Table 2 shows the relative growth development of 50 tobacco plants.

*Growth development.*—Table 2 shows that the height of the plants ranged from 147 to 205 cm. with an average height of 182.5 cm. Peralta and Paguirigan(5) also found under Los Baños, Laguna condition, that open grown Ilagan Sumatra attained an average height of 180.6 cm., and the average length and width of fresh standard leaves were 43.5 and 27.0 cm. respectively, breath index 62, with an average of 26.5 leaves per plant. In the Davao Penal Colony the length and width of fresh standard leaves averaged 51.08 and 33.3 cm. respectively, breath index 65.3, with an average of 25.5 leaves per plant. The figures obtained show that although the plants in Davao Penal Colony were a little bit taller, they had fewer number of leaves per plant than the plants at Los Baños. However, Davao plants developed big leaves with high breath index while the leaves of the Los Baños plants were small and had breath index of 3.3 per cent less.

TABLE 2.—*Field data of 50 flowering tobacco plants*

| Plant number | Height | Number of leaves per plant | Fresh standard leaves | | Breadth index |
|---|---|---|---|---|---|
| | | | Length | Width | |
| | *cm.* | | *cm.* | *cm.* | *per cent* |
| 1 | 174 | 25 | 49 | 33 | 67.34 |
| 2 | 159 | 26 | 47 | 32 | 68.09 |
| 3 | 173 | 25 | 53 | 33 | 62.26 |
| 4 | 183 | 25 | 46 | 31 | 67.39 |
| 5 | 190 | 26 | 49 | 32 | 65.30 |
| 6 | 200 | 26 | 52 | 36 | 69.23 |
| 7 | 190 | 25 | 55 | 41 | 73.21 |
| 8 | 180 | 25 | 56 | 36 | 64.28 |
| 9 | 190 | 26 | 48 | 32 | 66.66 |
| 10 | 190 | 24 | 48 | 34 | 70.83 |
| 11 | 195 | 26 | 54 | 32 | 59.25 |
| 12 | 190 | 27 | 60 | 35 | 58.33 |
| 13 | 200 | 27 | 54 | 37 | 68.51 |
| 14 | 190 | 25 | 55 | 35 | 63.36 |
| 15 | 200 | 26 | 52 | 34 | 65.38 |
| 16 | 200 | 24 | 45 | 33 | 73.33 |
| 17 | 205 | 25 | 51 | 33 | 64.70 |
| 18 | 190 | 25 | 52 | 34 | 65.38 |
| 19 | 180 | 24 | 52 | 34 | 65.38 |
| 20 | 190 | 24 | 50 | 35 | 70.00 |
| 21 | 147 | 24 | 47 | 24 | 51.06 |
| 22 | 180 | 27 | 52 | 30 | 57.69 |
| 23 | 170 | 27 | 52 | 27 | 51.92 |
| 24 | 185 | 25 | 50 | 34 | 68.00 |
| 25 | 180 | 24 | 54 | 33 | 61.11 |
| 26 | 175 | 25 | 51 | 32 | 74.50 |
| 27 | 160 | 25 | 50 | 32 | 64.00 |
| 28 | 168 | 24 | 50 | 38 | 76.00 |
| 29 | 170 | 26 | 52 | 30 | 57.69 |
| 30 | 172 | 25 | 50 | 29 | 58.00 |
| 31 | 190 | 25 | 50 | 38 | 76.00 |
| 32 | 180 | 25 | 51 | 34 | 66.66 |
| 33 | 180 | 25 | 54 | 30 | 55.55 |
| 34 | 180 | 27 | 47 | 38 | 80.85 |
| 35 | 180 | 25 | 53 | 30 | 56.60 |
| 36 | 185 | 27 | 50 | 37 | 74.00 |
| 37 | 180 | 25 | 51 | 26 | 50.98 |
| 38 | 180 | 25 | 50 | 27 | 54.00 |
| 39 | 175 | 25 | 53 | 30 | 56.60 |
| 40 | 170 | 24 | 47 | 24 | 51.06 |
| 41 | 201 | 28 | 54 | 40 | 74.07 |
| 42 | 180 | 24 | 48 | 33 | 68.75 |
| 43 | 147 | 26 | 56 | 39 | 69.64 |
| 44 | 180 | 25 | 52 | 34 | 63.38 |
| 45 | 190 | 26 | 52 | 35 | 67.30 |
| 46 | 202 | 26 | 51 | 33 | 64.70 |
| 47 | 180 | 31 | 49.5 | 37 | 74.00 |
| 48 | 190 | 27 | 48 | 35 | 72.91 |
| 49 | 190 | 26 | 50 | 35 | 70.00 |
| 50 | 190 | 25 | 50 | 34 | 68.00 |
| Average | 182.5 | 25.5 | 51.08 | 33.3 | 65.35 |

The leaves of the tobacco plants in the Central Office, Manila, were shorter and narrower than the leaves of the tobacco plants grown in Los Baños. It is obvious therefore that they were also poorer than those grown in Davao Penal Colony.

The differences in the growth development and especially in the quality of the leaves produced in these three places tried were to a certain extent due to the influence of the climate prevailing in the region. Table 3 shows the quality of tobacco leaves grown in Los Baños, Laguna; Central Office, Manila; and Davao Penal Colony, Davao.

TABLE 3.—*The quality of open grown cigar-wrapper leaf tobacco in the Philippines compared with imported Sumatra cigar-wrappers*

| Criteria | Location | | | |
|---|---|---|---|---|
| | Los Baños, Laguna | Manila | Davao | Medan, Sumatra [a] |
| Average length of cured standard leaves ..... cm.. | 39.9 | 30.8 | 41.0 | 39.26 |
| Average width of cured standard leaves ..... cm.. | 21.4 | 17.5 | 25.8 | 20.86 |
| Average thickness of lamina ............ micron.. | 73.00 | 75.0 | 43.05 | 38.00 |
| Average diameter of veins ................ mm.. | 0.43 | 43.0 | 0.421 | 0.32 |

[a] Imported cigar-wrapper.

Peralta and Paguirigan(5) state that "to be a good wrapper the leaf should be—thin—and should have fine veins." Of the open grown cigar-wrapper leaf tobacco raised in Los Baños, Laguna; Central Office, Manila; and in Davao Penal Colony, Davao, the plants grown in Davao produced the finest veins and the thinnest lamina (Table 3) but still the leaves were 12 per cent (5.05 microns) thicker than the famous imported Sumatra cigar-wrapper. However, the Davao Penal Colony tobacco leaves were 41 and 43 per cent thinner than the leaves of plants grown in Los Baños and Manila respectively.

Weaver and Clements(6) state that "Every plant is a product of the condition under which it grows and is therefore a measure of environment." The absence of a complete set of measurements of habitat factors in those three places tried, the growth development of the plants grown there can be used therefore with relative accuracy as a measure or indicator of the nature of the climate in Los Baños, Laguna, at Manila, and at Davao Penal Colony.

Peralta and Paguirigan[5] showed that when the aggregate effect of aërial environmental factors is not favorable for tobacco plants to transpire fast, the plant develops broad and thin leaves, the desired good qualities of cigar-wrappers. The fact that the leaves of tobacco raised in Davao Penal Colony (Table 3) were longer, broader and thinner than either the tobacco leaves produced at Los Baños, Laguna, and at Manila indicates that the rate of transpiration of the tobacco leaves at Davao was slower than the rate of transpiration of the leaves of plants grown in Los Baños or in Manila. Therefore, the aggregate effect of aërial environmental factors at Davao is not favorable for rapid transpiration for tobacco plants, further indicating that the climate at Davao Penal Colony is more humid than the climate prevailing in Laguna or in Manila. Under this condition, Davao Penal Colony is a suitable place for raising open-grown cigar-wrapper in the Philippines.

*Production and Cost.*—From an area of 5,850 sq. m. an actual crop of 19 quintals of tobacco leaves was realized. Out of the total crop, 84 per cent were good cigar-wrappers and 16 per cent were either for binders or fillers. Based from these figures, a hectare would yield 25.2 quintals of good cigar-wrapper and 4.8 quintals for either binders or filler.

The crop (not classified) was sold at public auction at ₱1.35 per kilo by the employees of the Davao Penal Colony, whereas open grown cigar-wrapper leaves raised at Los Baños and at Manila were appraised at ₱0.60 per kilo.[5]

The average total expenditures for the production of ordinary cigar-filler tobacco is about ₱229.80 per hectare. Since the cultural operations of the cigar-filler type and the open grown cigar-wrapper leaf tobacco are almost the same except that at Davao, the "banking method" was adapted which increased the total expenses to ₱100 more, making a total of ₱329.80 per hectare.

Basing from the actual results obtained, a hectare under Davao Penal Colony would give a gross income of ₱1,701 without taking into consideration the cost of 4.8 quintals that were only good for either binder or filler. Deducting the total expenditures of ₱329.80 from ₱1,701 a net gain of ₱1,371.20 would be realized.

SUMMARY

Trial plantings of the wrapper type of tobacco was tried under open condition at Los Baños, Laguna; Central Office, Manila;

and at Davao Penal Colony, Davao during the 1934 to 1935 tobacco season. The results obtained at Davao Penal Colony had the best quality of cigar-wrapper leaf tobacco. The planting of tobacco at Davao was repeated in 1935–1936 tobacco seasons and observations were taken on the prevalence of pest and diseases and the growth and development of the tobacco plants.

Fine grade of cigar-wrapper leaf tobacco was raised at Davao. The size and the color of the leaves produced compare favorably with the famous imported Sumatra cigar-wrapper leaf tobacco. As regards the thinness of the lamina of the leaf, the open grown cigar-wrapper at Davao was only 5.05 microns thicker (12 per cent) than the fine grade imported Sumatra cigar-wrapper leaf tobacco, but the leaves raised at either Los Baños, Laguna and at Central Office, Manila were inferior to that of the Davao Penal Colony production.

A kilogram of not classified cigar-wrapper leaf tobacco raised at Davao, was sold at public auction at ₱1.35 and the Los Baños product was only appraised at ₱0.60 a kilogram. The big difference in the selling price of the crop was mainly due to the thinness of the leaves and its good color, both qualities being the products of the environment of the plant. It is very apparent therefore that Davao Penal Colony has a set of climate favorable for successful growing of open grown cigar-wrapper leaf tobacco.

The monthly rainfall observed at Davao Penal Colony during a period of four consecutive years compare favorably with the mean monthly precipitation at Medan, Sumatra. With this condition and with the use of a good variety of tobacco, cigar-wrapper leaf tobacco can be raised under open condition at Davao Penal Colony with a big margin of profit. In so far as the places tried Davao is the best place, but still it is possible that some other places in Mindanao may be more appropriate for the growing of open grown cigar-wrapper leaf tobacco than Davao. We are still in search of this place.

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# ILLUSTRATIONS

### PLATE 1

Tobacco plantation (5,850 sq. m.) at Davao Penal Colony, Davao. Note the uniformity of the growth stand of the plants.

### PLATE 2

Curing Shed at the Davao Penal Colony constructed at a very low cost.

### PLATE 3

Two tobacco plants of Ilagan Sumatra variety affected with midrib rot at the Davao Penal Colony.

### PLATE 4

A close up view of open grown Ilagan Sumatra during the first priming period at the Davao Penal Colony.

PLATE 1.

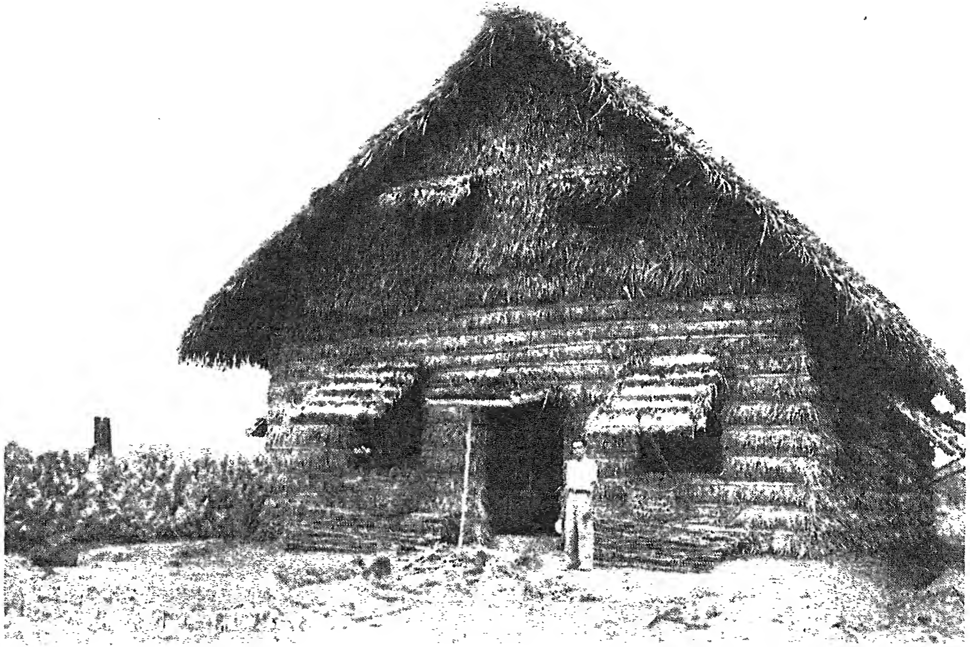

PLATE 2.

PLATE 3.

PLATE 4.

# A NEW RAT TRAP AND HOW TO LAY IT

By Leodegario E. Hachero

*Acting Superintendent, Gandara Seed Farm*

The general feature of this trap is based upon the principle of pitfall trap construction. Pitfall traps, like pitfall or bascule bridges, have even been used in strategem. In ancient times warring tribes constructed bascule bridges held on hidden springs to trap approaching enemies. In Mindanao the Moros use pitfall traps against their enemies. The Moro pits are dug on roads or pathways and are equipped with missiles such as sharpened stakes planted upright on the bottom of the pit, which is provided with an earthen covering suspended on improvised railings, the surface of which appear as natural as a trodden road. This contrivance is used in a small scale, portable and easier to handle in the war against rats.

The rat is considered one of the most dangerous enemies of man and agriculture. The loss from its ravages, chiefly in the destruction of human foodstuffs and food plants, is enormous. Since time immemorial this fact has been recognized, so science has been resorted to in the fight against this dangerous animal. As a result, modern chemical poisons are used to kill rats, and traps have been invented to reduce destructions by this pest.

Most of the traps now in use are dependent upon a single spring movement, that is, everytime the spring is released, it has to be readjusted before thê trap is ready to catch again. The trap described here may be left in a strategic point, without the necessity of readjusting. It gets the victims one after another in succession. It is believed that with the use of this trap and its sub-devices, like the cemented pit in the illustration the hazards experienced with the use of the poisons which are too delicate to handle and dangerous both to human being and domestic animals, would be reduced.

Our rocky hills unfit for agriculture, country canyons, river banks, caves, outcrops of stones, bamboo thickets, alleys of buildings in cities and surroundings of permanent storehouses where rats live can be provided with the kind of bascules (Fig. 1) used in this trap. A little expense for this purpose will insure

crop production against losses due to ravages of rats and reduces the cost and human effort that would have to be spent yearly for the campaign against rats.

## LAYING UP THE TRAP

During the dry season, it is the habit of mice to select damp places for dwelling, especially those surrounding the fields of grains, canes, root crops, storehouses or in domestic places. Their presence in the fields may be detected by the signs of small winding paths under the bushes which are frequently littered with grain hulls, straws, and twigs or leaves of herbs. Following these signs, the sides of dikes, banks of nearby rivers or creeks, thickets or outcrop of stones and the surrounding stamps, logs and the foot of the big trees should be searched for holes. Upon discovering the lodging places, the strategic points where to lay the traps are next determined. Generally, these places should be between the grain field and the lodging area. If baiting is contemplated, it is necessary to broadcast the kind of bait available sporadically on the area selected for the traps, at least three days before the traps are finally laid. Roasted corn, copra meat, and dried fish are attractive baits.

At the selected points, holes are dug to fit the tin can pit. The can should be planted in a standing position at such depth that when the detractors (Fig. 1) are placed, the bascules (Fig. 1) are on the same level with the surface of the ground. After setting the can in position, attach the detractor assemblies, the bascules in the cleats (Fig. 2), adjust the levers (Fig. 2, c) to the drawback springs (Fig. 2) and lock the cleats. Level the ground around the can with the counterbalance (Fig. 1) evenly suspended on the ground and the plungers (Fig. 1) at even edges. Water is important here as its depth in the can will prevent the rodent from getting a foothold on the bottom in its effort to leap out. A previously prepared bait such as what was broadcasted a few days before, is dropped inside the can to float on the water. Corrosives or acids may be dissolved in the water to harm the sight of the rodent provided strong scented ones are avoided. Lye is almost odorless when dissolved in water and this may answer the purpose.

In some localities it may become necessary to use a galvanized iron fence which are set in opposite directions or perpendicular to the back of the detractors. This will force the traffic of the rodents to the driveway.

The trap thus laid is visited every morning and afternoon to empty it of its victims. A blacksmith's tongue or the ordinary charcoal tongue may be used to catch the rodents inside the trap. After killing, they are either buried or burnt. Any predacious animal caught alive within that interval of inspection should be turned loose.

The trap can be left in the same place as long as there are catches. Usually the mice stay in the same place as long as left-overs from the harvest exist in the farm. But when the farm is plowed at the advent of the wet season or when the food is depleted or predacious animals become abundant, the hordes move, sometimes in troops, towards the populated places like the barrios, towns and cities, storehouses, or else in search of new places for food supply, like orchards, forests and wild grains in the grassy highlands. This is important to remember, for in so failing, the trapper, may believe that when there is no more rats caught in the traps the situation is controlled.

If their movements are carefully trailed and if the trapper uses good judgment in laying up the traps the work will yield better results.

In areas surrounding farm houses and in towns and cities, the trap can be used to advantage. The place for setting the traps are easily determined and their inspection requires but a short time. Since chickens, cats and small puppies may be caught in the trap, it is necessary to provide a cover for the bascules. The cover is placed at day time and removed at night. If the puppies roam about at night, a fence of slats is constructed and put across the driveway allowing only enough for the rat to pass through.

The rat trap can also be used in the house. If a cut can be made in some part of the house floor where the trap can be fitted, the trap will work.

In washing troughs where rats take a nip at night, the trap can also be used. This will require two pieces of boards, the end of one being placed on the edge of the trough and the end of the other to a railing where the rats pass towards the trough. The other two ends of the two boards must be set apart to leave a space for the trap. The trap is suspended on a char or a box so that the level of the boards and the bascules are even. The trap is left there to work.

In storehouses where grains or foodstuffs are kept, cemented pits as illustrated here can be constructed. The pit should be

set exactly at the corner of the buildings, its length to coincide with the direction of the hiprafter. This position has a general command of any approach to the building. The pit is provided with a shoulder about its brim and about an inch deep. This serves as a hold for the framework conveying the bascule and the detractor attachments. An outlet opening at the bottom is made with an inch pipe. This is for discharging the water when it begins to emit a foul odor. A small pocket hole or a notch is made about the waist side of the pit and provided with a perforated galvanized cover. This is for storing the bait.

A wooden plank made to the size of the framework holding the bascule and detractor attachments is needed. In domestic places the framework is taken off in daytime and the wooden plank placed on the pit to avoid domestic animals and children stumbling into the pit.

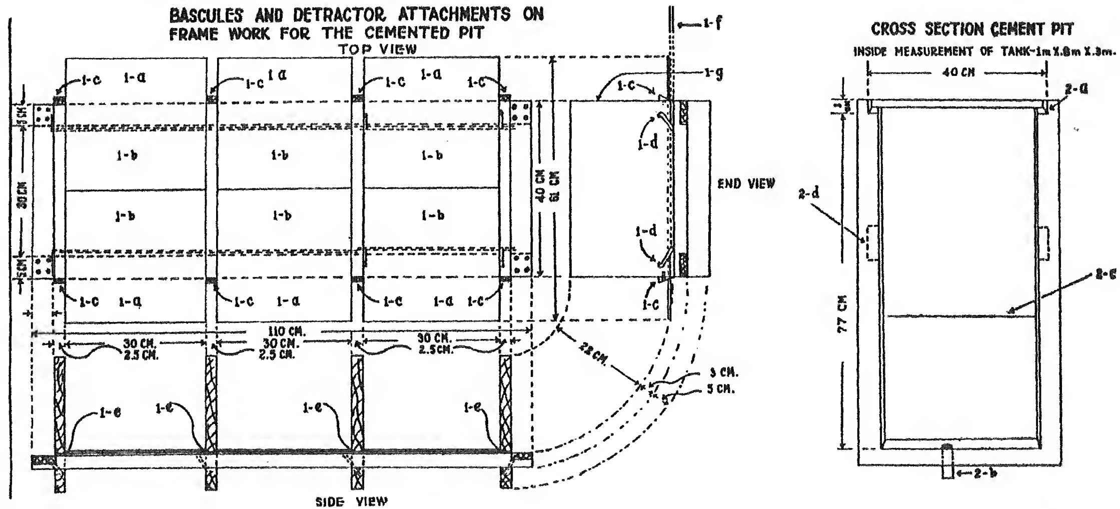


FIG. 3. Bascules and detractor attachments on framework for the cemented pit; and cross section of cement pit: 1-a—Counterbalance, 1-b—Plunger, 1-c—Cleat locks, 1-d—Lever, 1-e—Axle cleats, 1-f—Axle cleat pin, 2-a—Shoulder, 2-b—Outlet pipe, 2-c—Waterline, 1-g—Detractor, and 2-d—Notch for bait.

# ILLUSTRATIONS

TEXT FIGURES

# FARMERS' CIRCULAR SECTION

# GRAPE CULTURE

Farmers' Circular No. 41

By LEON R. AQUINO
*Junior Agronomist*

One of the many highly priced fruits that is being imported to this country is the grape, *Vitis spp.*, locally known as *uvas* in Spanish, *parras* in Visaya, and *uvas* or *pasas* in Tagalog. Trials to grow this plant have been made in the different regions of the Philippines but with little success, and it is only recently when its culture was undertaken to an appreciable extent by fancy growers.

## VARIETIES

Wester (1924) gave the following descriptions of the different species and varieties of grapes introduced into the Philippines or found growing here long ago:

**"Grape-Labrusca, Vitis labrusca L.** VITACEÆ

"A perennial, woody tendrilled, deciduous vine, indigenous to eastern United States. The leaves are rather thick, dark-green above, downy or velvety beneath, and less cleft than vinifera. The fruits are borne in bunches, and are round, variously colored, sweet, juicy, and of excellent eating quality. The "Isabella" variety has been introduced recently from Hawaii, where it thrives both in wet and dry locations, and is well established in Manila and Zamboanga.

**"Grape-Muscadine, Vitis rotundifolia Mx.** VITACEÆ

"A woody, perennial vine, with thin, smooth, light green leaves, native of southern United States. The fruits are borne singly or in small bunches, and are thick-skinned and variously colored, with well flavored, sweet flesh. The following varieties have been introduced: Eden, Flowers, James, Labana, Lasalle, Mish, San Jacinto, San Melaska, and Thomas, but the growth at Lamao has not been satisfactory.

**"Grape-Vinifera, Vitis vinifera L.** VITACEÆ

Local Name: Uvas, Spanish; Parras, Visayan.

"A perennial woody, deciduous, tendril-bearing vine with thin smooth leaves, deeply incised, native of Caucasus to Western

India. The globular fruits are borne in bunches in the axils of the leaves and are variously colored, from green and white to red, purple and black, fleshy, sweet and juicy and of excellent eating quality. A green variety with small bunches and rather juicy fruits is more or less distributed throughout the archipelago, and commonly known as the 'Cebu Grape.' Judiciously pruned it yields good crops. The Spaniards undoubtedly introduced many of their grape varieties of which only the above-mentioned 'Cebu Grape' has gained a permanent foothold and makes a very vigorous growth and strong healthy vines. Many varieties, probably both vinifera and labrusca grapes, were also imported about 1905 by this Bureau for trial at Lamao all of which died within a short time.

"In this case of failures with the grafted plants these may have been due to stocks unsuitable to Philippine conditions and where rooted cuttings were used it might have been due to an inherently weak root system or by being planted where the climatic conditions were altogether uncongenial. It is well within the possibilities that many varieties of grapes would thrive here grafted on the 'Cebu Grape.' Other grape stocks might also be imported to advantage. The highlands of the northern part of Bukidnon would appear particularly adapted to grape culture. In Florida a grape industry is now being built up based on the culture of the following varieties which would appear worth introducing into the Philippines: Armalaga, Brilliant, Carman, Concord, Csaba, Delaware, Ellen Scott, Fern, Goethe, Headlight, Ives, Niagarra and R. W. Munson."

The last species *Vitis vinifera L.*, is considered the most adapted specie in the Philippines. Several varieties are widely grown from northern Luzon to the Visayas and Mindanao and, under what we may still call improper way of culture, they are giving fairly good fruits. In the Visayas, particularly in Oriental Negros and Cebu, the "Cebu grape" and other closely related or identical varieties are found thriving well and producing fairly good fruits with practically very little care. The common practice in these regions is to plant a couple of plants near the house and allow them to cover the porch or small shed in the year which serve for ornamental purposes, while at the same time some fancy fruits are expected in due time. Little cultivation or cultural attention is given to the plants. From the experiences of early growers pruning is being practiced as this has been found to be a prerequisite to make the plant bear fruits.

## CULTURE

Grape is propagated by cuttings, marcotting and layering. It can also be grafted on suitable stocks. Seeds from fresh fruits also germinate but vegetative propagation is recommended, as the plant will come into bearing much sooner than the seeds and there is less chance for variations from the parent plant. Propagation by cutting is more commonly practiced than either marcotting or layering.

Medium-matured to matured vines with good buds are best suited for cutting purposes although immature cuttings also give some percentage of success. Preserving the cuttings in moist sphagnum moss for a period of ten to fourteen days was found by the writer to give a higher percentage of success than when they are immediately planted after cutting from the mother plant. Cuttings may be planted either direct on the permanent place or on nursery plots. In the first case proper protection from the excessive heat of the sun is to be made until the cuttings are well started, that is, when the new shoots are sufficiently matured and there are already well-established root systems. Cuttings propagated in the nursery are transplanted after they are also well started.

Grapes thrive best in light fertile soil with good drainage. They may be grown in any ordinary soil, but proper drainage has to be provided for in case this is necessary. In case the soil has poor fertility complete fertilizer may be applied as in any other plant if good production is to be expected.

Grape vines are always provided with trellis or shed (*balag*) for support and on which their branches may spread uniformly. Only healthy and equally distributed branches should be allowed to develop. Pruning should start as early as possible to stimulate rapid growth on the desirable vines although the regular pruning should be done on well-developed plants after about a year. In some places layering of grapes are being practiced but the rooted vines are not severed from the mother plants. These rooted vines are allowed to grow on the same shed or are extended to a new shed without disturbing their original position or direction. For this purpose only the overhanging vines along the sides of the shed that reach the ground are used for layering and the tip branches are again directed to the shed. This way of expanding the area of the vine is recommended if the trellis is low and in a standing position.

In field culture under commercial scale the trellis should be in standing position and each plant should cover a more limited area. Figure 1 shows the arrangements of the trellis and the manner in which the vines should be trained.

In commercial field culture the plants should be set at a distance of 5 meters in the rows while the rows should be 4 meters apart. With these measurements a hectare of land can hold 500 plants. Irrigation facilities should be provided during the dry season if they are available. Likewise, proper drainage should be provided during the rainy season.

The length of the fruiting vines should be maintained during the season or replaced when necessary. Uniform distribution of the vines should also be maintained in order to insure uniform fruiting. Pruning to train the vines should start as early as

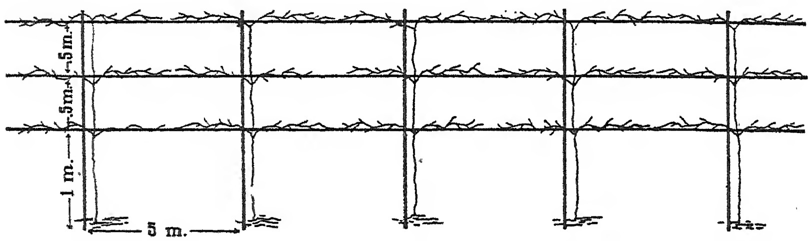


FIG. 1. Illustrating the position of the trellis and the arrangement of the vines.

possible and should be done frequently. General pruning to induce fruiting should be done after the plants have attained the age of at least one year. The general pruning is recommended from July to September so that the fruits will mature from November to January. Where the plants are in a condition for pruning at other times, this can be accomplished in the production of out-of-season fruits. Application of complete fertilizer at the rate to be determined according to the condition of the land can be made before the rainy season commences.

Some grape growers believe that grape thrives best and gives good production when located in a place where it receives full sunlight in the morning and partly shaded in the afternoon. This may be true on the lowlands with warm climate during certain seasons of the year, but shades may be dispensed with in high altitudes with cooler climate. Grapes are sensitive to strong wind, hence they should be provided with protection from this.

*Pruning.*—Grapes must be pruned in order to bring the plants into bearing. Although occasionally we find some vines bearing

fruits without pruning, yet the plants should be pruned regularly to get the expected normal production. Usually the first pruning can be done when the plant is about a year old. Under favorable conditions a single plant must have spread its vines to an area of from 12 to 16 square meters after one year. This, of course, depends upon the conditions of the soil, climate of the locality and the treatment given to the plant. It has been observed that, to maintain a heavy production, the area of the spreading vines should also be limited. From 12 to 16 square meters of equally distributed vines for every plant is considered sufficient.

In pruning grapes all young vines and all leaves are removed. Matured but sickly or undesirable vines are also taken off. Vines of the previous season are considered mature so that those of the latest season are all to be pruned. This can also be determined by the color of the vine. About two to three weeks after pruning new shoots begin to show up with one to four bunches of flowers in every new shoot. The bigger and more healthy the young shoots are, so are the flowers they produce; hence, only the most healthy vines are to be left. The flowers appear at the first to the fourth axils of the first four leaves of the young shoots. It is the practice of experienced grape growers to spare in the next pruning the bases of the last season's growth, one to four nodes, or the region where the last season's fruits appeared. The fruits mature in about ten to twelve weeks from flowering. After the fruits are harvested or while harvesting another pruning may be done for the next fruiting.

Pruning may be done any time of the year. However, if heavy production is expected, the pruning should be done just before or at the beginning of the period of rapid growth of the plant. However, if fruits are desired at certain seasons of the year pruning may be done accordingly. The general principles of pruning should be followed in grapes as in other plants or trees. Pruning in general has the following purposes:

1. To keep the plant well-balanced and well-formed.
2. To give equal distribution of plant food and sunlight.
3. To remove undesirable branches and to prevent serious damages by crowding of branches.
4. To make picking and control of pests and diseases more effective.
5. To thin the fruits.
6. To rejuvenate old trees.

## PESTS AND DISEASES

The pests and diseases of grapes observed to be prevalent during certain seasons of the year are as follows:

*Bugs.*—The bugs appear during the rainy season when the plants are in active growth. The insects eat the leaves at night as in roses and other similar plants. Upon the appearance of the pests the plants may be sprayed or dusted with calcium arsenate. For spraying use 8 to 14 spoons (levelful) of this chemical to every petroleum canful of water depending on the tenderness of the leaves of the plant. The spray should be stirred well while spraying. For dusting, pure calcium arsenate should be mixed with gao-gao in the proportion of one of calcium arsenate to 2 to 10 parts of gao-gao by volume. Spraying or dusting should be done late in the afternoon and should be repeated after every two days until the pests disappear.

*Anthracnose.*—The disease appears during the rainy season when there is continuous heavy rain. It first appears as scattered spots of rotting or drying on the leaves but later it will cause almost all the leaves to be in rotting or drying condition. This affects also the general growth of the plant. The disease should be sprayed with Bordeaux mixture. If the plant is in the condition for pruning it should be pruned and all the leaves and branches that had been removed should be burned.

## PRODUCTION

Under the conditions in Oriental Negros which is practically the average condition in many parts in the Philippines, grapes give fruits any season of the year. With continuous judicious pruning grape vines may produce three times a year. However, to get the maximum production and at the same time maintain the vigor of the plant, pruning and fruiting should take once a year only. Under this condition regular production from year to year may be expected and the plants remain in a vigorous condition to resist pests and diseases and other adversities. Under ordinary conditions a single plant with vines covering about 15 square meters may give a production of from 15 to 25 kilos of fruits in one fruiting season. Under very favorable conditions and with particularly good care the plant may be pruned to induce fruiting more than once a year. Out of season fruits always have the advantage in the market.

Under commercial grape culture the cost of planting and maintenance of one hectare and the production under average conditions in the Islands are estimated as follows:

FIRST YEAR

*Expenses.*—The expenses for the first year are incurred in the thorough preparation of the land (three times plowing and harrowing and planting to beans or other legumes); cost of planting materials (500 rooted cuttings); staking and planting (plantings could be done even if the field is still planted with legumes); watering and early care and up-keep; cost of materials for trellis; replantings that may be needed; weeding and general cultivation; pruning and control of pests and diseases; and the general up-keep of the plantation. The total expenses at the end of the first year is estimated, under average conditions, at ₱137.00.

*Income.*—No income is expected at the end of the first year except the harvest from legumes which is not added to income from the principal crop.

SECOND YEAR

*Expenses.*—The expenses for the second year consist of occasional pruning; cultivation and weeding (4 times a year); the general pruning to induce fruiting; preparation and propagation of cuttings that may be obtained; general up-keep of the plantation; and harvesting and crating of the first fruiting. The first fruiting is expected at the end of the second year if the planting is done at the proper time and proper care given.

| | |
|---|---|
| Total expenses for the second year | ₱30.00 |
| Expenses for the first year | 137.00 |
| Total expenses at the end of the second year | ₱167.00 |
| Income: At least 200 rooted cuttings should be produced during the second year, valued at ₱0.05 each | ₱10.00 |
| At least 100 kilos of fruits are expected at the end of the second year which could be sold (wholesale, at ₱0.40 per kilo | 40.00 |
| Total income at the end of the second year | ₱50.00 |
| Total expenses up to the end of the second year | ₱167.00 |
| Total income at the end of the second year | 50.00 |
| Unrecovered expenses at the end of the second year | ₱117.00 |

THIRD YEAR

*Expenses.*—The expenses during the third year are the same as those of the second year with the increase in the harvesting and crating.

| | |
|---|---|
| The total expenses is estimated at | ₱51.00 |
| Unrecovered expenses at the end of the second year | 117.00 |
| Total expenses at the end of the third year | ₱168.00 |
| Income: 500 rooted cuttings | ₱25.00 |
| At least 1,000 kilos of fruits are expected to be harvested at the end of the third year, valued at | 400.00 |
| Total income at the end of the third year | ₱425.00 |
| Total unrecovered expenses at the end of the third year | 168.00 |
| Net income at the end of the third year | ₱257.00 |

FOURTH YEAR

*Expenses.*—The expenses during the fourth year are the same as those of the third year with the addition of fertilizer and fertilizer application; repairs of trellis and increase in harvesting, crating and general up-keep.

| | |
|---|---|
| The total expenses estimated at | ₱120.00 |
| Income: 500 rooted cuttings | ₱25.00 |
| At least 2,000 kilos of fruits (normal production) valued at | 800.00 |
| Total income at the end of the fourth year | ₱825.00 |
| Expenses for the fourth year | 120.00 |
| Net income for the fourth year | ₱705.00 |

The estimated expenses are based upon average conditions in the different regions of the Islands. The laborers to undertake the work from the start and the maintenance of the plantation are expected to have certain experience along this line or should be under the supervision of an experienced man. The estimates in the production are based upon actual records of bearing vines particularly those found in the province of Oriental Negros. Records of those old grape vines show that productions are obtainable even from plants over ten years old, even without the best care that they should have. Even at the age of over ten years, with proper up-keep of the plantation and the necessary rejuvenation now and then, normal production can still be expected. The success or failure in the production of grapes in a commercial scale depends, of course, upon the adaptability of the plant in the locality and the manner by which the enterprise is to be undertaken from the start.

REFERENCE

WESTER, P. J. 1924. The food plants of the Philippines, Bureau of Agriculture Bulletin No. 39.

# BRIEF INSTRUCTIONS ON WEAVING ON HOME-MADE LOOMS

(Farmers' Circular 42)

By EUGENIO E. CRUZ and FELIPE CORTES

*Of the Bureau of Plant Industry*

ELEVEN PLATES AND ONE TEXT FIGURE

## INTRODUCTION

Following the economic slogan of self-sufficiency in prime necessities and the industrialization of raw materials with a view to provide employment as well as to increase the income of the people, the Bureau of Plant Industry has taken the lead in pushing the development of household weaving by improving the looms and studying the possibilities of local fibers for making useful and salable articles.

Household weaving, though a traditional occupation in the Philippines, has not been thoroughly developed and as yet no complete information regarding its operation and scope have been written and brought to the attention of the public. In answer to several inquiries and to guide the provincial pensionados who come to the Bureau of Plant Industry to learn more about weaving and other interested parties, the present paper was prepared.

## GENERAL PRINCIPLES

In weaving (see Plate 1) several operations are involved; namely, preparation of heddles and reed, preparation of the yarn, sizing, knotting, spooling, warping, beaming, drawing in, weaving and finishing.

## PREPARATION OF HEDDLE FRAME, NEEDLE, HEDDLES AND REED

(*a*) *Heddle frame.*—This consists of two longitudinal pieces of wood supported at the base with stable wood braces as shown in Plate 2. Four pieces of wood are transversely fastened to these two pieces of wood forming parallel bars. The distance from the first and fourth transverse bars must correspond to the length of the desired heddles. The second and third pieces

are so placed between the first and fourth that a hollow space between them is formed. This space serves as the place where the "mail eye" of the heddle is formed. The distance between

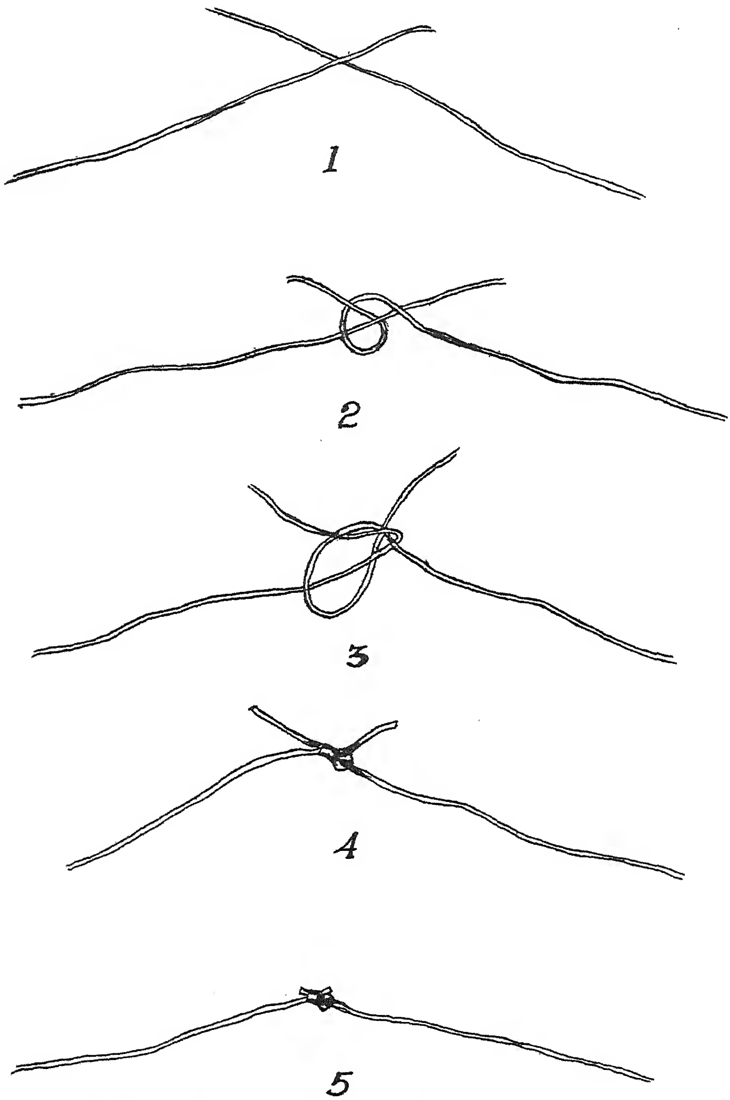


FIGURE 1.—Showing the different steps in knotting abacá, piña, etc. in the Philippines.

these transverse bars varies depending altogether upon personal judgment.

Another heddle frame may be made, such as rectangular frame from four pieces of wood. Another piece equipped with a ridge,

is fastened to the two longitudinal pieces parallel to the two bases serving as transverse bars of the frame. The ridge opening of the middle piece is held in place by a wooden peg fastened to the right longitudinal piece of the frame.

(*b*) *Needle.*—A needle is made of a thin piece of bamboo stick, pointed at one end and depressed at the other (see illustration, Plate 2). At the center of this needle stick a ridge is made in such a way that a thin uniformly rounded splint is formed leaving at its sides a hollow gap which circumscribes its pointed end near the needle's blunt end. Before healds could be made, a considerable amount of threads should first be wound up from the depressed end of the needle to the thin uniformly rounded piece in the ridge.

(*c*) *Heddle.*—Heddles (see Plate 3) are made in various ways. The general principle involved is such that the cord forming a heddle is tied to the heddle frame in a way that an opening at the center through which a warp thread passes is made. This opening or eye is called the "mail eye." The method employed is as follows: With the needle loaded, the thread end is tied at the center bar and drawn forward passing around the lower transverse bar and the back of the frame upward, then winding it again around the top bar forward. A knot is made close to the top edge of the center bar and then another at its under edge. The process is continued until the desired number of healds is made. The top knot in a heald is made by inserting the needle-stick, whose thread forms the front thread, around the back thread forming a loop, then holding both thread and part of the loop adjoining it firmly with the left hand and finally passing the needle through the loop from below embracing part of the loop thread at the same time. Push the loop tightly closed to the top edge of the center bar of the heddle frame, then pull the long end of the thread downward until a perfect knot is formed. The under knot is prepared in the same manner as the upper knot.

(*d*) *Reed.*—The texture and quality of the cloth determine the thickness of the splints in the reed and the dents or spaces formed by them. If the cloth to be woven is coarse the splints in the reed should be wide. The kind and width of the cloth also determine the number and length of splints and dents in the reed, so that more and longer splints and dents are required in making a blanket than in making a towel. In foot-power weaving the splints for reed are usually made of bamboo.

The reed is made by first preparing the splints. The splints must be selected from strong, well-seasoned and thoroughly dried bamboo. They should be of uniform length, breadth and thickness and each provided with a notch for tying at each end. The breadth between the two notches in a splint must be narrower than that from the notch at each end (see Plate 4). Two pairs of bamboo slats are then prepared and set parallel to each other, while a much bigger splint is tied perpendicularly at the end of each pair. This splint fixes the width of the reed. Every splint is inserted through the two pairs of bamboo slats by perpendicularly wedging one notch in between the first pair and the other notch in between the second pair.

The tying at each end of the splint to the parallel pairs of bamboo slats is done by using two needle sticks like that used in making heddles. Each needle stick is first loaded with cotton thread and then tied to one pair of the parallel slats. Then tie each end of the splint by making a counter-clockwise loop around the paired slats. Each time a splint is inserted into the parallel paired slats the two needle sticks also work because there are two ends in the splint to tie to.

## PREPARATION OF THE YARN

Ascertaining the amount of cotton yarn to be prepared for warp before attempting to weave any desired fabric is essential in the preparation of the yarn. Usually cotton yarns are bought from the store in the form of hanks. A hank of Nos. 10 and 20 cotton yarn consists always of seven skeins, each skein measuring 120 yards or approximately 110 meters. If there are seven skeins in a hank, therefore, one hank measures 840 yards or 770 meters. It is important for weavers to ascertain the approximate length of a hank as this will enable them to know the number of hanks to be sized for the warp of a desired fabric to be woven. For warp, yarn No. 20 is commonly used, particularly in blanket and towel weaving. For filling, yarn No. 10 in used both for towels and blankets.

In abacá burlap weaving, abacá grade DL, considered as waste, is employed both for warp and filling. The fibers are usually woven dry but since dry fibers become brittle during the process of weaving, rinsing with water from time to time will soften and strengthen them.

Low grade abacá fibers like "J2" and "K" are made into ropes and are also used as warps in the manufacture of rugs and door mats. Sometimes abacá fiber is adulterated with

coir and maguey in door mat weaving, the coir being useful as fillings. Warp yarns may be either dyed or not at all, depending upon the fancy of the producer and consumer.

### SIZING

By sizing is meant the starching and brushing to dryness of cotton yarn until ready for spooling (see Plate 5). The principles involved are the thorough penetration of starch grains into each individual thread in the hanks. The purpose is to strengthen the yarn. This is done by beating and brushing the excess starch in the hanks to insure uniformity in the treatment and complete separation into uniform size of individual thread. If the cotton yarns are thoroughly sized, the threads are almost hard, strong and easy to spool. On the other hand, if they are improperly starched the threads stick to each other and are soft, weak and hard to spool.

### KNOTTING

Knotting goes hand in hand with spooling (see Plate 6). It is a preliminary process commonly used among the fibers which have not been joined or twisted by machine like abacá, piña, maguey, etc. It is done whenever there occurs a break in the warp threads. In the Philippines, knotting is a time-consuming process for it is done by hand and much time is spent before sufficient amount of yarn is obtained. Knotting is done by placing the ends of the threads to be knotted one above the other so as to form an X. A loop is made with the under-thread around the intersection. At the same time the end of the top-thread is forced into the loop by encircling the intersection with it from above. Then it is pulled from below until a perfect knot is formed.

### SPOOLING

Spooling (see Plates 7 and 8) is a process by which the yarn is wound around a bamboo tube by means of a spooler or reeler as shown in Plate 2. Usually the "madejas" or hanks are set on a skeiner supported by a rack or stand as shown in Plates 7 and 8. The end of the first skein, the first of the seven ties in the hank or "madeja," is wound around an empty bamboo tube. This is placed on a spooler which is operated by hand. Spooling is made easier if it begins from the first to the seventh or last skeins. On the other hand, if a thread end is selected at random the threads become crowded and considerable amount of time and thread is wasted.

Knotting abacá, maguey, and piña yarns are spooled not from skeins but from baskets, basin, etc., where the knotted yarn is placed preparatory to spooling.

### WARPING

Warping is the process of assembling the required thread strands into parallel order, the number of threads in the warp corresponding to the width of cloth desired (see Plate 9). The length of the warp threads will approximately be the length of the finished cloth minus the waste.

In warping, a series of warp bars about 10 inches long are nailed to two posts as shown in (Plate 5). The yarn to be warped is placed in spools which are always even in number. Warp threads are passed through equidistant paired nails attached to a piece of wood. The threads are taken in pairs preparatory to winding them around the warp bars. This piece of wood through which the threads pass is supported by racks. If there are 20 spools of yarn the thread ends are knotted in pairs so that 10 pairs of thread are gathered and inserted in a crossing or twisting position through the fingers, i. e., one pair of thread is above the other. If there are 10 pairs of threads used, 5 pairs are inserted above and 5 pairs below. From the first warp bar of one post the paired threads are fastened and allowed to pass through two parallel sticks where the crosses or twisted pairs are inserted and then wound around the first warp bar of the second post. The cross or twist formed by the thread pairs becomes the cross of the warp through which two pieces of wood called shed sticks are later fastened during the process of threading. The main function of the shed sticks is to keep the cross of the warp intact. If the cloth to be woven is 18 meters long and the distance from post to post is 3 meters, the paired threads are wound back and forth around the warp bars 6 times or 3 times each way. The threads are then continued until the number of threads corresponding to the width of the cloth desired is set. The other end of the warp yarn may or may not be in place where the paired threads started. This is inserted in the warp bars in a crossing or twisting position in the same way as in the fingers described above. The twist or cross formed here serves as guide for another two pieces of wood which, like the shed sticks, facilitate the arrangement of the warp threads when fastened to the warp roller. The closing of the warp should take place at the post where the

paired threads started and the top pairs knotted with the under pairs around the warp bar where they end.

As soon as the required number of threads is fixed the twists or crosses are tied in place to keep cross of warp intact, and the warp is unraveled first from where the paired threads started and then braided until the end is reached.

The exact amount of hanks of cotton yarn and the required number of threads for the width of the warp are determined by ascertaining the number of dents in the reed. For instance, if the width of the cloth desired is 18 inches and there are 32 dents to the inch in the reed, the number of dents required in the reed is 576 or 18 by 32. But usually in blankets, towels, abacá linen and jusi cloth two threads are drawn in each dent. In towel where 576 dents are needed in the reed the exact number of threads required for the warp should be twice as much or 1,152 threads. If the exact length of the towels to be woven is 18 meters, then 1,152 multiplied by 18 equals 20,736 meters which would be the required length of the cotton yarn. The following may serve as illustration: Since there are 770 meters of yarn in a "madeja" or hank, therefore, the number of hanks required in 20,736 meters would be the quotient of 20,736 divided by 770, or 26.92 hanks which would be necessary as warp of a towel cloth 18 inches wide by 18 meters long. As a safety factor, 1 or 2 hanks are added to 26.92 hanks, depending upon the skill of the weaver in sizing and spooling of the yarn.

## BEAMING

Beaming is the winding and spreading of the warp yarn from the warp roller through the warp and the cloth beams (see Plate 10). A piece of stick is passed through the end of the warp where the paired threads during the warping process end and close. This stick is fastened securely at each end to the warp roller with strings or ropes of equal length. This is done to make the drawing in of the warp even throughout. Two pieces of wood are then inserted through the twist or cross. The other end of the warp where the paired threads started is tightly pulled forward by one person while two others keep the warp threads spread uniformly on the warp beam. The spreading of the warp threads on the warp beam is facilitated with the aid of a wood lever which rolls the warp roller clockwise or counter-clockwise.

DRAWING IN

After beaming, the other end of the warp yarn is loosened. Two pieces of stick which serve as the shed sticks are first inserted through the twist or cross and then the ends of the warp threads uniformly cut. The heddles whose number corresponds to the number of threads in the warp are then apportioned equally among the paired shafts. This depends on the number of "leaf healds" or paired shafts containing healds or heddles. The shafts are tied at each end to the warp beam and each thread end of the warp is drawn in each heald through the "mail eye." The operation involved follows carefully the design or pattern in the draft for the cloth to be woven. As soon as all the threads have been drawn in the healds the warp ends are tied into knots or "bouts." Each knot may contain 20, 50 or more threads. A reed containing the required number of dents is tied at each end to the leaf healds or paired shafts. As already described each dent or division in the reed may be inserted with one or two warp threads but in blanket, towel and jusi weaving, usually two threads are drawn in each dent. Having been all drawn in the dents, the warp threads are then tied into knots in the same way as in the leaf healds to keep the warp ends from pulling off the reed. The reed is finally set in the beater.

WEAVING

A double string is passed through each knot and wound around a piece of stick. This stick is gently fastened at each end to the cloth beam with strings or ropes of equal length in order to make the winding of the finished cloth in the cloth beam and the fillings even throughout during the process of weaving. The leaf healds are fastened to the heddle horse which may either be pulleys or wood slats and form the harness of the loom. Usually if there are four pairs of heddle shafts the first and the third pairs are tied to the first treadle, which on stepping lowers down the first and third pairs of heddle shafts. The second and fourth pairs of heddle shafts are also tied to the second treadle. This is true in plain weaving where the filling and warp are almost the same in amount. If the yarn used is coarse, only two pairs of shafts and two treadles are used; but if finer yarn is used, four to eight pairs of shafts are employed in order to make finer weave and to facilitate weaving.

In blanket and towel weaving the number of treadles corresponds also to the number of paired heddle shafts employed and each paired shafts is tied to its corresponding treadle, as heddle

shaft No. 1 to treadle No. 1 and so on. In twill weaving where two pulleys are used on each side, the first and third paired shafts are fastened to one pulley on each end while the second and fourth paired shafts to the second pulley. But Nos. 1, 2, 3, and 4 shafts are also tied to Nos. 1, 2, 3, and 4 treadles, respectively. The shed sticks are then moved backward while those previously inserted during the process of beaming are removed.

Having put the shafts and beater in perfect working order the weaver is ready to weave.

Weaving is the process of interlacing at right angles two or more threads of which the longitudinal is called warp and the transverse weft, or filling. To supply the filling the weaver employs a shuttle which contains a bobbin of threads supported inside with a wire or very thin piece of stick. The weaver throws in the shuttle back and forth transversely through a desired shed or opening in the warp produced by a corresponding step on the treadle. Simultaneously, the filling is driven home by means of the beater. The process of throwing in the shuttle back and forth is called picking and the driving home of every filling with the beater or batten is called beating or battening. The filling threads are called picks and the warp threads ends. Thirty-two ends to the inch means that there are 32 transverse warp threads in one inch distance in the cloth. Thirty-two picks to the inch also means that there are 32 longitudinal filling threads in one inch distance in the cloth. The ends of the fillings forming the edges of the finished cloth is called selvage. A tenter-hook or slat of wood provided with small nails at each end is attached to the finished cloth closed to the unwoven warp to keep the width of the cloth stretched and prevent the weaver from tightly pulling every filling thrown in. The purpose of the beater or batten is to make the filling of the cloth compact, even and solid.

When the finished cloth is to be wound up in the cloth beam and a part of the warp is to be drawn in, a lock consisting of a wheel controlled by a wood working like a lever is released and the hook inserted into a hole of the warp roller, pulled off. The lock and hook keep the warp yarn stretched or loosened when necessary.

The shed sticks are moved backward and forward in the warp. If the weaver desires a wider opening in the warp, she moves the shed sticks backward and vice-versa. The shed sticks keep the cross of the warp intact and enable the weaver to locate

breaks in the warp threads by moving them forward and backward.

### FINISHING

When the finished cloth is to be cut while the warp yarn is still long, the warp threads should be cut not too close to the cloth to prevent unraveling of the cloth. Knots are uniformly made at the warp ends to prevent the warp threads from pulling off the reed.

Finished blankets, towels, and jusi clothes need some trimmings before they are marketed. The edges of the blankets and towels must be uniformly and neatly knotted. The excess threads in the design of the jusi clothes should be neatly trimmed.

Plate 11 shows some of the samples of the cloth woven in the Bureau of Plant Industry:

### ECONOMICS OF WEAVING

How much does a weaver need to start weaving? This will depend upon several factors. The following information are given for amateur weavers:

MATERIALS NEEDED FOR ONE-PIECE REDSPREAD

| | |
|---|---|
| Equipment: | |
| 1 Aldaba loom (complete set) | ₱50.00 |
| 1 Spinner to match | 7.00 |
| 1 Heddle frame | 2.00 |
| Materials: | |
| 1 Bundle No. 20 yarn (white) | 4.10 |
| 4 Bundles No. 10 yarn (white) | 15.60 |
| 57 Balls thread, No. 40, at ₱0.02 per ball | 1.14 |
| 10 Packages starch, at ₱0.05 per package | .50 |
| Total | ₱80.34 |

From the above, 14 blankets each weighing 1.1 kilos and measuring 2.2 meters long by 1.55 meters wide can be obtained. One of these sells at ₱4 in Manila.

MATERIALS NEEDED TO WEAVE JUSI

| | |
|---|---|
| Equipment: | |
| 1 Malabon loom (complete set) | ₱36.00 |
| Materials: | |
| 1 Bundle jusi yarn No. 7 | 30.00 |
| 6 Hanks bleached cotton, at ₱0.40 per hank | 2.40 |
| 2 Packages dye (Mcdeon, at ₱0.10 per package | .20 |
| 8 Balls thread No. 20, at ₱0.02 per ball | .16 |
| 10 Boxes Clark's anchor Pearl cotton No. F897, at ₱1.20 per box | 12.00 |
| Total | ₱80.76 |

YARNS NEEDED FOR WEAVING THE DIFFERENT KINDS OF CLOTH VARY IN PRICES DEPENDING UPON THE SIZE AND QUALITY

*Abacá.*—In the Bicol region strips of abacá yarn for sack making are sold at ₱0.04 a kilo. The prices of the plain abacá burlap, F. O. B. Manila are as follows:

| | Price per meter |
|---|---|
| 35 cm. wide | ₱0.03½ |
| 48 cm. wide | .0475 |
| 50 cm. wide | .05 |
| 65 cm. wide | .07 |
| 65 cm. wide (Twill) | .08 |
| 65 cm. wide (Double) | .14½ |

One bale of abacá fiber "CD" costs ₱28 at Manila.

One suit of abacá linen 6 meters long under conditions obtaining in the Bureau of Plant Industry consumed actually 875 grams of mercerized abacá yarn "CD".

*Cotton.*—Quotations of cotton yarn as given by the different companies on October 14, 1936 were as follows:

MITSUI BUSSAN KAISHA

| | |
|---|---|
| No. 20—Gray (per bale) | ₱148.00 |
| No. 20—White (per bale) | 155.00 |
| No. 32—White (per bale) | 205.00 |
| No. 40—White (per bale) | 215.00 |

WISE & COMPANY

| | |
|---|---|
| No. 24—Red yarn (per bale) | ₱170.00 |
| No. 30—Red yarn (per bale) | 180.00 |
| No. 30—Red yarn (per bale) (Kasa nipa) | 165.00 |
| No. 48—Red yarn (Fish and Bull) | 120.00 |

Each bale contains 40 bundles and each boundle weighs 10 lbs.

GOOD MORNING STORE

| | |
|---|---|
| No. 30—Mercerized (white) per bundle (As of October 14, 1936) | ₱11.75 |
| No. 30—Mercerized (white) per bundle (As of December 12, 1936) | 13.60 |

The quotations, weight per head and weight per bundle of dyed mercerized cotton yarn No. 30 from Good Morning Store as of December 12, 1936 are as follows:

| Color of yarn | Cost per bundle | Net weight per head *grams* | Net weight per bundle *grams* |
|---|---|---|---|
| Red | ₱14.00 | 156.6 | 4,698 |
| Black | 14.00 | 154.3 | 4,629 |
| Yellow | 14.00 | 148.7 | 4,461 |
| Rose | 14.00 | 147.3 | 4,419 |
| Green | 14.00 | 146.3 | 4,389 |

BUREAU OF PLANT INDUSTRY

| | |
|---|---|
| No. 10—Cotton yarn (per bale) | ₱3.20 |
| No. 20—Cotton yarn (per bale) | 3.60 |
| No. 10—Cotton yarn, bleached (per bale) | 4.70 |
| No. 20—Cotton yarn, bleached (per bale) | 5.20 |

There are 20 heads in a bundle of No. 20 yarn. Each head contains 10 "madejas." There are 20 heads also in No. 10 yarn but each head contains only 5 "madejas." In the case of the mercerized cotton there are 20 heads also in a bundle and each head contains 10 "madejas."

To make one blanket 2.2 meters long and 1.55 meters wide, 15 "madejas" of No. 20 as warp and 30 "madejas" of No. 10 as filings are needed.

The cost of production of some of the clothes woven in the Bureau of Plant Industry under experimental conditions are given below:

COST OF PRODUCTION OF ONE-PIECE BLANKET

(1.55 by 2.2 meters)

| | |
|---|---|
| Materials: | |
| Cost of 15 hanks needed for warp No. 20 yarn, at ₱0.02 | ₱0.30 |
| Cost of 30 hanks needed for filling No. 10 yarn, at ₱0.038 per hank | 1.14 |
| Labor: | |
| Sizing 15 hanks (105 skeins) for warp, one-half day, at ₱0.80 | .40 |
| Spooling 15 hanks for warp, 2 hrs. at ₱0.10 | .20 |
| Spooling 30 hanks for filling, 4 hrs. at ₱0.10 | .40 |
| Loading for 1 blanket, 20 min. at ₱0.10 per hr. | .03 |
| Warping yarn for 1 blanket, 1 hr. at ₱0.10 | .10 |
| Threading yarn for 1 blanket, 1 hr. at ₱0.10 | .10 |
| Reeding yarn for 1 blanket, 1/2 hr. at ₱0.10 | .05 |
| Weaving 1 blanket, 1 day at ₱0.80 | .80 |
| Finishing 1 blanket, 1/2 day at ₱0.80 | .40 |
| Total | ₱3.92 |
| Selling price per blanket | ₱4.00 |
| Profit | .08 |

COST OF PRODUCTION OF ONE TOWEL

(18 by 29 inches)

| | |
|---|---|
| Materials: | |
| 1.28 hanks for warp No. 20 yarn at ₱0.02 | ₱0.0256 |
| 1.6 hanks for filling No. 10 yarn at ₱0.038 | .0608 |
| Labor: | |
| Sizing 1.28 hanks, 1/3 hr. at ₱0.10 | .0333 |
| Spooling 1.28 hanks, 1/12 hr. at ₱0.10 | .0083 |
| Warping yarn, 1/5 hr. at ₱0.10 | .0200 |

| | |
|---|---|
| Loading yarn, 1/5 hr. at ₱0.10 | ₱0.0200 |
| Threading yarn, 1/8 hr. at ₱0.10 | .0125 |
| Spooling 1.6 hanks for filling, 1/10 hr. at ₱0.10 | .0100 |
| Weaving 1 hr. at ₱0.10 | .1000 |
| Sewing 1.5 min. at ₱0.10 per hour | .0024 |
| Total | ₱.2929 |
| Selling price per towel | ₱.30 |
| Profit | .0071 |

COST OF PRODUCTION OF ONE METER OF ABATEX

(1/3 cotton and 2/3 abacá)

| | |
|---|---|
| Cost of materials: | |
| 0.047 kilo cotton at ₱0.80 | ₱0.038 |
| 0.095 kilo abacá at ₱0.90 | .086 |
| Labor: | |
| Preparation of the materials, 1/4 of a day at ₱0.60 | .150 |
| Warping, loading, threading and reeding | .071 |
| Weaving, 1/3 day at ₱0.80 | .270 |
| Depreciation and supervision | .002 |
| Total | ₱0.617 |

COST OF PRODUCTION PER PILE TOWEL

(22½ by 35 inches)

| | |
|---|---|
| Materials: | |
| 1.53 hanks, yarn No. 20 at ₱0.02 | ₱0.0306 |
| 1.35 hanks, yarn No. 10 at ₱0.038 | .0513 |
| Labor: | |
| Sizing, 2.88 hanks, 2/3 hr. at ₱0.10 | .0664 |
| Spooling, 1.53 hanks, 1/10 hr. at ₱0.10 | .0100 |
| Warping, 2/5 hr. at ₱0.10 | .0400 |
| Loading, 2/5 hr. at ₱0.10 | .0400 |
| Threading, 1/4 hr. at ₱0.10 | .0250 |
| Spooling, 1.35 hanks for filling, 1/12 hour at ₱0.10 | .0083 |
| Weaving, 1 towel in 2 hours at ₱0.10 | .2000 |
| Finishing, 1½ hrs. at ₱0.10 | .1000 |
| Total | ₱0.5716 |

COST OF PRODUCTION OF 6 METERS (1 TERNO) MERCERIZED COTTON

(4 ply filling)

| | |
|---|---|
| Materials: | |
| Warp, 2.448 heads No. 30 at ₱0.3916 | ₱0.960 |
| Filling, 5.02 heads No. 30 at ₱0.3916 | 1.960 |
| Labor: | |
| Weaving, 1 woman, 2½ days at ₱0.80 | ₱2.000 |
| Spooling warp, 2.448 heads, 1 woman, 1½ hrs. at ₱0.10 per hour | .150 |

| | |
|---|---|
| Spooling fillings, 5.02 heads, 1 woman 3.26 hours at ₱0.10 per hour | ₱0.326 |
| Loading, 1/4 hr. at ₱0.10 | .025 |
| Warping, 6 meters long, 1 woman .65 hours at ₱0.10 per hour | .065 |
| Threading, 5 hrs. at ₱0.10 per hr. | .500 |
| Total | ₱5.986 |
| Selling price | ₱6.000 |
| Gain | .014 |

COST OF PRODUCTION OF ONE PIECE PATADIONG

(3.5 meters)

| | |
|---|---|
| Materials: | |
| 2.6 madejas No. 30 for filling at ₱0.0933 per madeja | ₱0.242 |
| 3.5 madejas No. 30 for warp at ₱0.0933 | .326 |
| Labor: | |
| Spooling, 6.1 madejas for filling and warping, 1/4 hr. at ₱0.1375 per hr. | ₱0.039 |
| Warping, 1/2 hr. at ₱0.1375 | .068 |
| Loading, 1/4 hr. at ₱0.1375 | .039 |
| Weaving, 2 days at ₱1.10 | 2.200 |
| Threading 2/3 hr. at ₱0.1375 | .105 |
| Total | ₱3.019 |
| Cost of production per meter of patadiong | ₱0.862 |

COST OF PRODUCTION OF COTTON RIBBON, 23.7 METERS RED, WHITE, BLUE

| | |
|---|---|
| Materials: | |
| 0.259 grams jusi for filling at ₱29.50 per 3,000 grams | ₱0.00254 |
| 2.19 madejas mercerized cotton for warp at ₱0.0933 per madeja | .20432 |
| Labor: | |
| Spooling 2.19 madejas mercerized cotton, 10 min. at ₱0.1375 per hour | .02291 |
| Spooling .259 grams jusi for filling, 50 minutes at ₱0.1375 per hour | .01145 |
| Warping, 1/4 hr. at ₱0.1375 per hr. | .03437 |
| Loading, 1/8 hr. at ₱0.1375 per hr. | .01718 |
| Threading, 3 min. at ₱0.1375 per hr. | .00687 |
| Cost of weaving, 10 days at ₱1.10 per day | 11.00000 |
| Total | ₱11.29964 |
| Cost of one meter | ₱.4767 |

*Jusi.*—Jusi yarn Nos. 6 and 7 are sold at ₱30 per bundle. Each bundle weighs 3 kilos and contains 23 heads. They are not in "madejas" like the cotton yarn. From one bundle of jusi yarn No. 6, 50 Camisa de chinos, each measuring 2.6 meters long and 60 centimeters wide, can be obtained. At the rate of

₱2 per Camisa de chino a weaver can therefore get ₱100 from a bundle of jusi yarn No. 6.

COST OF PRODUCTION OF ONE JUSI CAMISA DE CHINO

(63 × 275 centimeters)

| | |
|---|---|
| Warp yarn 34 grams or 1/4 head at ₱0.01 | ₱0.34 |
| Filling yarn 44 grams or 1/3 head at ₱0.01 | .44 |
| D. M. C. thread $2\frac{1}{2}$ balls at ₱0.17 | .42 |
| Spooling 7/12 heads or 78 grams at ₱0.20 | .11 |
| Warping 1/4 head or 34 grams at ₱0.12 | .03 |
| Weaving one Camisa de chino | .60 |
| Trimming extra thread or designs | .03 |
| Loading 1/4 head or 34 grams at ₱0.04 | .01 |
| Threading, 5 hrs. at ₱0.075 | .375 |
| Total | ₱2.355 |
| Selling price per Camisa de chino | ₱2.50 |
| Difference | .145 |

COST OF PRODUCTION OF ONE BARONG TAGALOG

| | |
|---|---|
| Warp yarn, 40.8 grams at ₱0.01 | ₱0.408 |
| Filling yarn, 54.4 grams at ₱0.01 | .544 |
| One "madeja," mercerized cotton at ₱0.07832 | .078 |
| Spooling 95.2 grams jusi and 1 "madeja" mercerized cotton | .150 |
| Warping, 40.8 grams | .037 |
| Weaving one Barong Tagalog | .600 |
| Threading, 5 hrs. at ₱0.075 | .375 |
| Trimming extra threads or designs | .037 |
| Loading | .010 |
| Total | ₱2.239 |
| Selling price | ₱2.500 |
| Difference | .261 |

COST OF PRODUCTION PER ETIQUETA

| | |
|---|---|
| Cost of .2 gram jusi for warp at ₱29.50 per 3,000 grams | ₱0.00190 |
| Cost of .55 grams thread at ₱0.12 per 11 grams | .00600 |
| Cost of spooling, 2 min. at ₱0.1375 per hour | .00458 |
| Cost of weaving, 5 min. at ₱0.1375 per hr. | .01145 |
| Cost of warping and loading, 3 min. at ₱0.1375 per hour | .00787 |
| Cost of threading, 3 min. at ₱0.1375 per hr. | .00787 |
| Total | ₱0.03967 |

*Silk.*—Silk yarn No. 32 are sold at ₱13 per kilo.

*Rayon.*—Imported Japanese Rayon (Art. No. 300) is obtainable in the market at ₱3.80 per kilo. One box contains 6 spools and weighs ½ kilo net. The weight of one spool is 93.4 grams.

| | |
|---|---|
| Spooling fillings, 5.02 heads, 1 woman 3.26 hours at ₱0.10 per hour | ₱0.326 |
| Loading, 1/4 hr. at ₱0.10 | .025 |
| Warping, 6 meters long, 1 woman .65 hours at ₱0.10 per hour | .065 |
| Threading, 5 hrs. at ₱0.10 per hr. | .500 |
| Total | ₱5.986 |
| Selling price | ₱6.000 |
| Gain | .014 |

COST OF PRODUCTION OF ONE PIECE PATADIONG

(3.5 meters)

| | |
|---|---|
| Materials: | |
| 2.6 madejas No. 30 for filling at ₱0.0933 per madeja | ₱0.242 |
| 3.5 madejas No. 30 for warp at ₱0.0933 | .326 |
| Labor: | |
| Spooling, 6.1 madejas for filling and warping, 1/4 hr. at ₱0.1375 per hr. | ₱0.039 |
| Warping, 1/2 hr. at ₱0.1375 | .068 |
| Loading, 1/4 hr. at ₱0.1375 | .039 |
| Weaving, 2 days at ₱1.10 | 2.200 |
| Threading 2/3 hr. at ₱0.1375 | .105 |
| Total | ₱3.019 |
| Cost of production per meter of patadiong | ₱0.862 |

COST OF PRODUCTION OF COTTON RIBBON, 23.7 METERS RED, WHITE, BLUE

| | |
|---|---|
| Materials: | |
| 0.259 grams jusi for filling at ₱29.50 per 3,000 grams | ₱0.00254 |
| 2.19 madejas mercerized cotton for warp at ₱0.0933 per madeja | .20432 |
| Labor: | |
| Spooling 2.19 madejas mercerized cotton, 10 min. at ₱0.1375 per hour | .02291 |
| Spooling .259 grams jusi for filling, 50 minutes at ₱0.1375 per hour | .01145 |
| Warping, 1/4 hr. at ₱0.1375 per hr. | .03437 |
| Loading, 1/8 hr. at ₱0.1375 per hr. | .01718 |
| Threading, 3 min. at ₱0.1375 per hr. | .00687 |
| Cost of weaving, 10 days at ₱1.10 per day | 11.00000 |
| Total | ₱11.29964 |
| Cost of one meter | ₱.4767 |

*Jusi.*—Jusi yarn Nos. 6 and 7 are sold at ₱30 per bundle. Each bundle weighs 3 kilos and contains 23 heads. They are not in "madejas" like the cotton yarn. From one bundle of jusi yarn No. 6, 50 Camisa de chinos, each measuring 2.6 meters long and 60 centimeters wide, can be obtained. At the rate of

₱2 per Camisa de chino a weaver can therefore get ₱100 from a bundle of jusi yarn No. 6.

COST OF PRODUCTION OF ONE JUSI CAMISA DE CHINO

(63 × 275 centimeters)

| | |
|---|---|
| Warp yarn 34 grams or 1/4 head at ₱0.01 | ₱0.34 |
| Filling yarn 44 grams or 1/3 head at ₱0.01 | .44 |
| D. M. C. thread 2½ balls at ₱0.17 | .42 |
| Spooling 7/12 heads or 78 grams at ₱0.20 | .11 |
| Warping 1/4 head or 34 grams at ₱0.12 | .03 |
| Weaving one Camisa de chino | .60 |
| Trimming extra thread or designs | .03 |
| Loading 1/4 head or 34 grams at ₱0.04 | .01 |
| Threading, 5 hrs. at ₱0.075 | .375 |
| Total | ₱2.355 |
| Selling price per Camisa de chino | ₱2.50 |
| Difference | .145 |

COST OF PRODUCTION OF ONE BARONG TAGALOG

| | |
|---|---|
| Warp yarn, 40.8 grams at ₱0.01 | ₱0.408 |
| Filling yarn, 54.4 grams at ₱0.01 | .544 |
| One "madeja," mercerized cotton at ₱0.07832 | .078 |
| Spooling 95.2 grams jusi and 1 "madeja" mercerized cotton | .150 |
| Warping, 40.8 grams | .037 |
| Weaving one Barong Tagalog | .600 |
| Threading, 5 hrs. at ₱0.075 | .375 |
| Trimming extra threads or designs | .037 |
| Loading | .010 |
| Total | ₱2.239 |
| Selling price | ₱2.500 |
| Difference | .261 |

COST OF PRODUCTION PER ETIQUETA

| | |
|---|---|
| Cost of .2 gram jusi for warp at ₱29.50 per 3,000 grams | ₱0.00190 |
| Cost of .55 grams thread at ₱0.12 per 11 grams | .00600 |
| Cost of spooling, 2 min. at ₱0.1375 per hour | .00458 |
| Cost of weaving, 5 min. at ₱0.1375 per hr. | .01145 |
| Cost of warping and loading, 3 min. at ₱0.1375 per hour | .00787 |
| Cost of threading, 3 min. at ₱0.1375 per hr. | .00787 |
| Total | ₱0.03967 |

*Silk.*—Silk yarn No. 32 are sold at ₱13 per kilo.

*Rayon.*—Imported Japanese Rayon (Art. No. 300) is obtainable in the market at ₱3.80 per kilo. One box contains 6 spools and weighs ½ kilo net. The weight of one spool is 93.4 grams.

| | |
|---|---|
| Spooling fillings, 5.02 heads, 1 woman 3.26 hours at ₱0.10 per hour | ₱0.326 |
| Loading, 1/4 hr. at ₱0.10 | .025 |
| Warping, 6 meters long, 1 woman .65 hours at ₱0.10 per hour | .065 |
| Threading, 5 hrs. at ₱0.10 per hr. | .500 |
| Total | ₱5.986 |
| Selling price | ₱6.000 |
| Gain | .014 |

COST OF PRODUCTION OF ONE PIECE PATADIONG

(3.5 meters)

| | |
|---|---|
| Materials: | |
| 2.6 madejas No. 30 for filling at ₱0.0933 per madeja | ₱0.242 |
| 3.5 madejas No. 30 for warp at ₱0.0933 | .326 |
| Labor: | |
| Spooling, 6.1 madejas for filling and warping, 1/4 hr. at ₱0.1375 per hr. | ₱0.039 |
| Warping, 1/2 hr. at ₱0.1375 | .068 |
| Loading, 1/4 hr. at ₱0.1375 | .039 |
| Weaving, 2 days at ₱1.10 | 2.200 |
| Threading 2/3 hr. at ₱0.1375 | .105 |
| Total | ₱3.019 |
| Cost of production per meter of patadiong | ₱0.862 |

COST OF PRODUCTION OF COTTON RIBBON, 23.7 METERS RED, WHITE, BLUE

| | |
|---|---|
| Materials: | |
| 0.259 grams jusi for filling at ₱29.50 per 3,000 grams | ₱0.00254 |
| 2.19 madejas mercerized cotton for warp at ₱0.0933 per madeja | .20432 |
| Labor: | |
| Spooling 2.19 madejas mercerized cotton, 10 min. at ₱0.1375 per hour | .02291 |
| Spooling .259 grams jusi for filling, 50 minutes at ₱0.1375 per hour | .01145 |
| Warping, 1/4 hr. at ₱0.1375 per hr. | .03437 |
| Loading, 1/8 hr. at ₱0.1375 per hr. | .01718 |
| Threading, 3 min. at ₱0.1375 per hr. | .00687 |
| Cost of weaving, 10 days at ₱1.10 per day | 11.00000 |
| Total | ₱11.29964 |
| Cost of one meter | ₱.4767 |

*Jusi.*—Jusi yarn Nos. 6 and 7 are sold at ₱30 per bundle. Each bundle weighs 3 kilos and contains 23 heads. They are not in "madejas" like the cotton yarn. From one bundle of jusi yarn No. 6, 50 Camisa de chinos, each measuring 2.6 meters long and 60 centimeters wide, can be obtained. At the rate of

₱2 per Camisa de chino a weaver can therefore get ₱100 from a bundle of jusi yarn No. 6.

COST OF PRODUCTION OF ONE JUSI CAMISA DE CHINO

(63 × 275 centimeters)

| | |
|---|---|
| Warp yarn 34 grams or 1/4 head at ₱0.01 | ₱0.34 |
| Filling yarn 44 grams or 1/3 head at ₱0.01 | .44 |
| D. M. C. thread 2½ balls at ₱0.17 | .42 |
| Spooling 7/12 heads or 78 grams at ₱0.20 | .11 |
| Warping 1/4 head or 34 grams at ₱0.12 | .03 |
| Weaving one Camisa de chino | .60 |
| Trimming extra thread or designs | .03 |
| Loading 1/4 head or 34 grams at ₱0.04 | .01 |
| Threading, 5 hrs. at ₱0.075 | .375 |
| Total | ₱2.355 |
| Selling price per Camisa de chino | ₱2.50 |
| Difference | .145 |

COST OF PRODUCTION OF ONE BARONG TAGALOG

| | |
|---|---|
| Warp yarn, 40.8 grams at ₱0.01 | ₱0.408 |
| Filling yarn, 54.4 grams at ₱0.01 | .544 |
| One "madeja," mercerized cotton at ₱0.07832 | .078 |
| Spooling 95.2 grams jusi and 1 "madeja" mercerized cotton | .150 |
| Warping, 40.8 grams | .037 |
| Weaving one Barong Tagalog | .600 |
| Threading, 5 hrs. at ₱0.075 | .375 |
| Trimming extra threads or designs | .037 |
| Loading | .010 |
| Total | ₱2.239 |
| Selling price | ₱2.500 |
| Difference | .261 |

COST OF PRODUCTION PER ETIQUETA

| | |
|---|---|
| Cost of .2 gram jusi for warp at ₱29.50 per 3,000 grams | ₱0.00190 |
| Cost of .55 grams thread at ₱0.12 per 11 grams | .00600 |
| Cost of spooling, 2 min. at ₱0.1375 per hour | .00458 |
| Cost of weaving, 5 min. at ₱0.1375 per hr. | .01145 |
| Cost of warping and loading, 3 min. at ₱0.1375 per hour | .00787 |
| Cost of threading, 3 min. at ₱0.1375 per hr. | .00787 |
| Total | ₱0.03967 |

*Silk.*—Silk yarn No. 32 are sold at ₱13 per kilo.

*Rayon.*—Imported Japanese Rayon (Art. No. 300) is obtainable in the market at ₱3.80 per kilo. One box contains 6 spools and weighs ½ kilo net. The weight of one spool is 93.4 grams.

Rayon woven with mercerized cotton yarn No. 30 makes a good material for shirts.

COST OF PRODUCTION OF ONE SHIRT, 3 METERS LONG (MERCERIZED COTTON WARP AND RAYON FILLING, SINGLE-PLY)

| | |
|---|---|
| Materials: | |
| 7.93 madejas No. 30 mercerized cotton for warp at ₱0.07832 | ₱0.621 |
| 147.91 grams rayon at ₱0.0038 | .562 |
| Labor: | |
| Spooling, 7.93 madejas mercerized cotton for warp, 1/4 hr. at ₱0.1375 | .034 |
| Warping 3 meters long, 1/2 hr. at ₱0.1375 | .068 |
| Threading, 1 hr. at ₱0.1375 | .137 |
| Loading 1/5 hr. at ₱0.1375 | .027 |
| Weaving, 1¼ days at ₱1.10 | 1.275 |
| Total | 2.724 |
| Cost of production of 1 meter | ₱0.908 |

TO FIND THE TOTAL TIME AND COST OF THE PREPARATION OF ONE BUNDLE COTTON YARN NO. 20

| | |
|---|---|
| Starching of 1 bundle, yarn No. 20 (200 hanks 1 day at ₱0.80 per day) | ₱0.80 |
| Brushing to dryness of 200 madejas, 3 days at ₱0.80 | 2.40 |
| Spooling of 200 madejas, 5 days at ₱0.80 | 4.00 |
| Total | ₱7.20 |
| Cost of 2 packages starch at ₱0.05 | .10 |
| | ₱7.30 |

SUMMARY

| | |
|---|---|
| Starching | 1 day |
| Brushing | 3 days |
| Spooling | 5 days |
| Total | 9 days |

# ILLUSTRATIONS

PLATE 1

Showing the ordinary method of weaving on an improved Ilocano loom.

PLATE 2

Showing the heddle frame held by the woman with her left hand and needle with the right hand.

PLATE 3

Showing the heddles in place. The woman is apportioning the heddle threads among the eight heddle sticks.

PLATE 4

Showing the reed (*a*) used in weaving cloth not more than 70 centimeters wide and reed (*b*) used in weaving cloth not more than 175 centimeters wide. Reed (*b*) is commonly used in weaving one-piece bedspread.

PLATE 5

Showing the ordinary method of starching and brushing. The woman looking in front with her two hands above the basin is starching. The woman with her back at the camera and handling a coir brush with her left hand in brushing the starched yarn to dryness.

PLATE 6

Showing the woman in actual knotting operation.

PLATE 7

An ordinary method of spooling cotton, silk and jusi yarn.

PLATE 8

Showing the method of spooling cotton yarn in a multiple spooler. Note that it takes only one to operate the three spoolers arranged in one series. This multiple spooler was devised by the senior author.

PLATE 9

Showing the common method of warping. Note the threads from spooled yarns on the floor being pulled out by the woman through equally distanced paired nails above.

PLATE 10

Showing the common method of beaming in the warp yarn. Note the woman arranging and spreading the warp threads on the warp beam while the man at the center helps the woman at his back to keep the warp yarn stretched.

PLATE 11

Showing the samples of finished products woven in the Bureau of Plant Industry.

TEXT FIGURE

FIG. 1.—Showing the different steps in knotting abacá, piña, etc. in the Philippines.

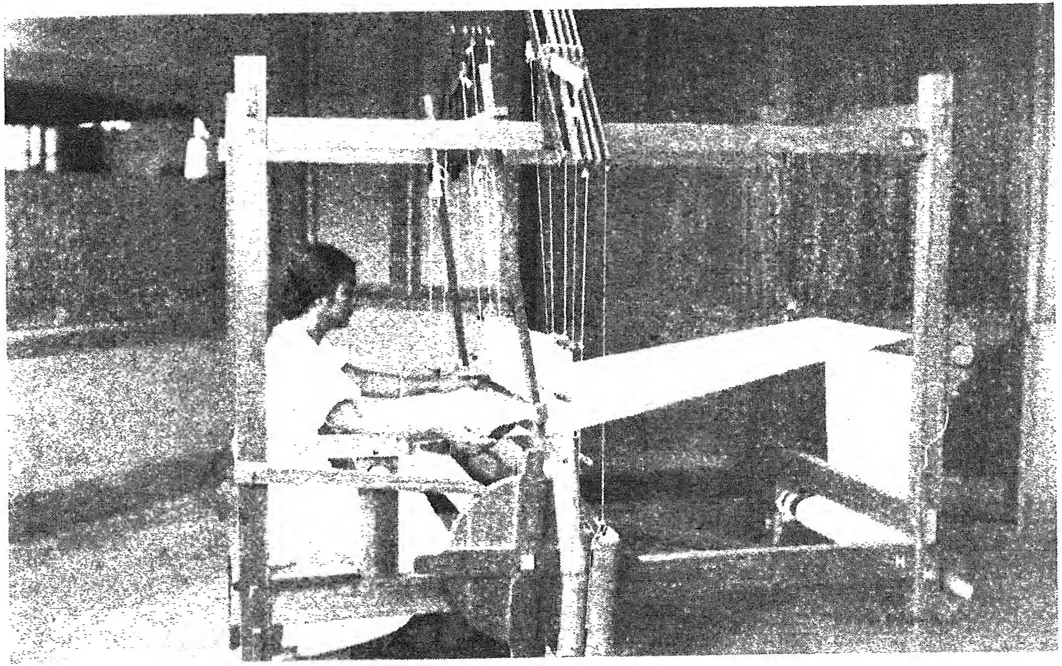

PLATE 1.

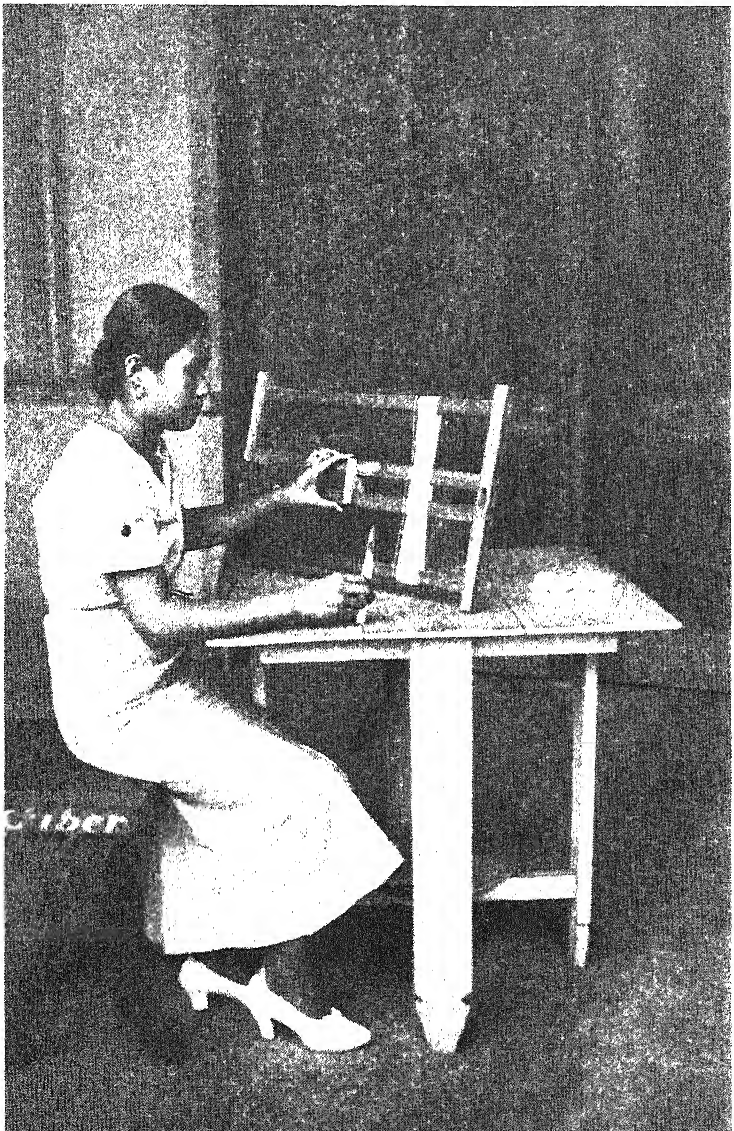

PLATE 2.

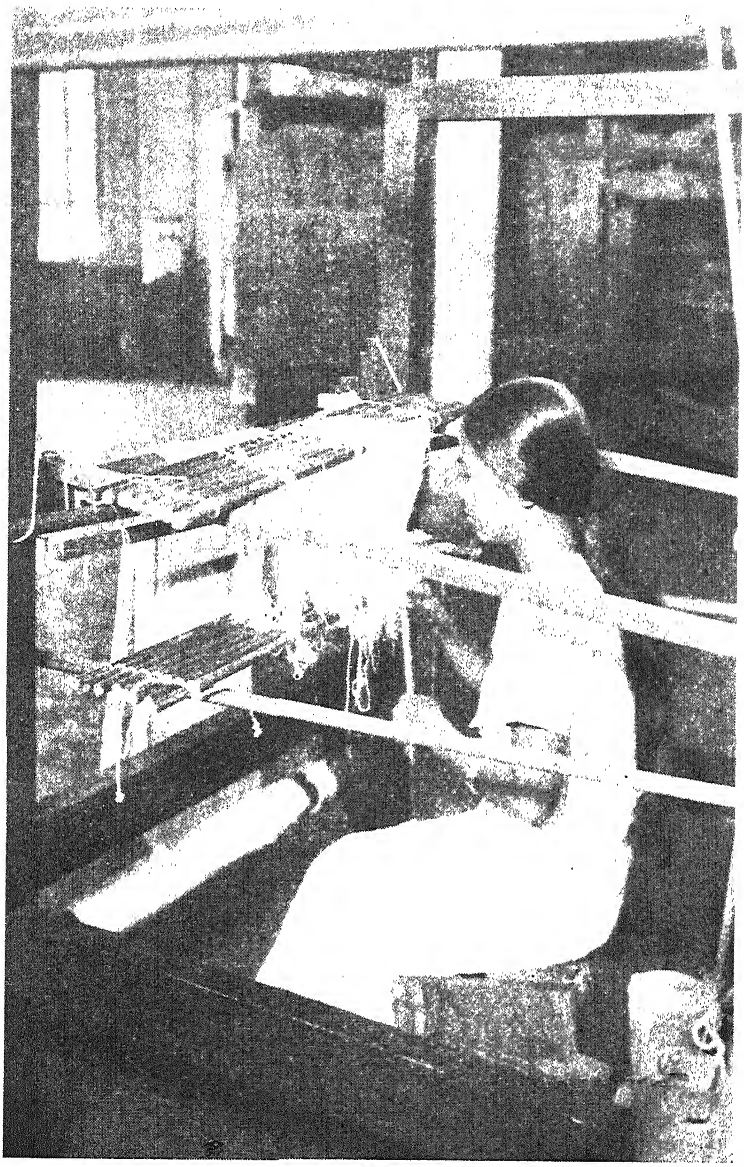

PLATE 3.

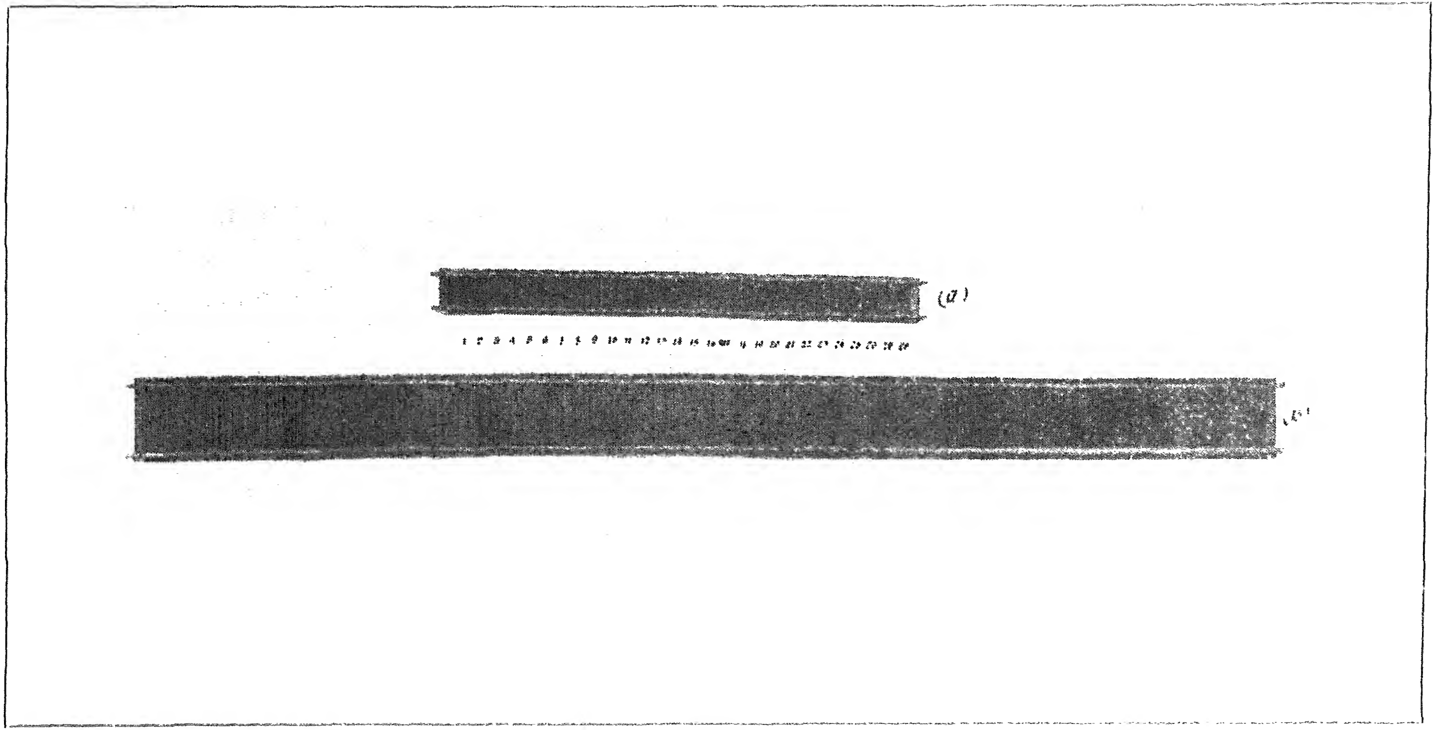


PLATE 4.

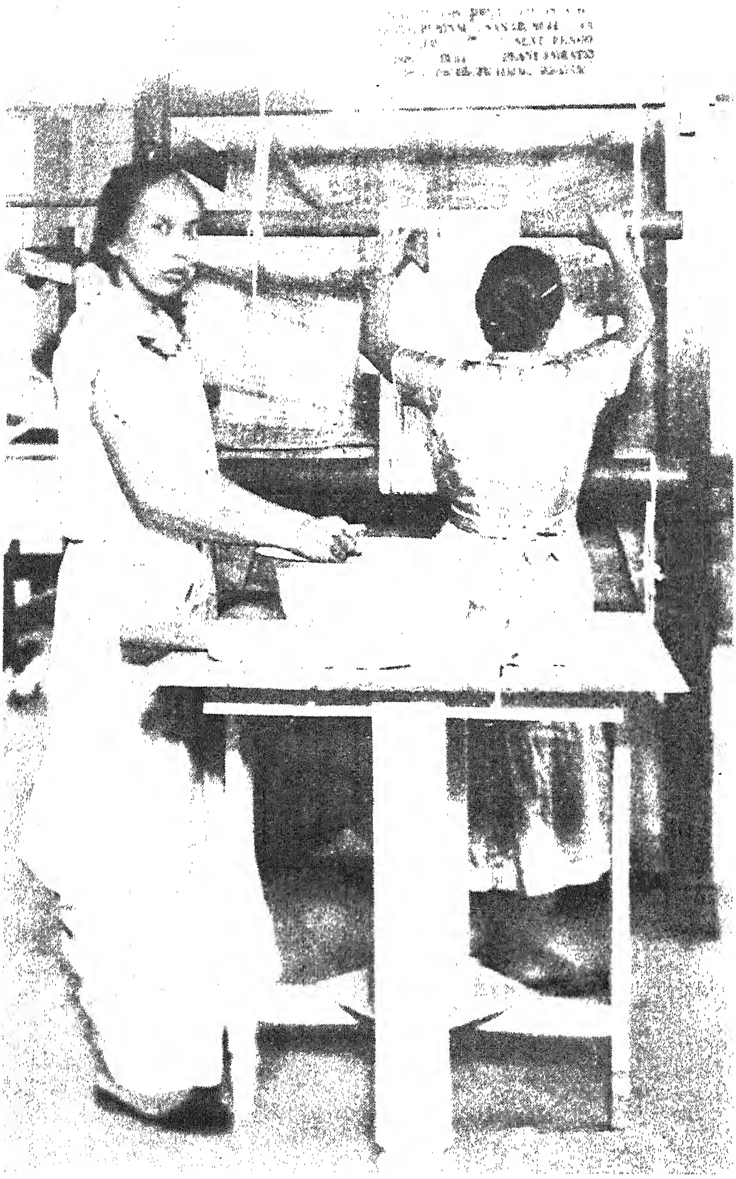

PLATE 5.


PLATE 6.

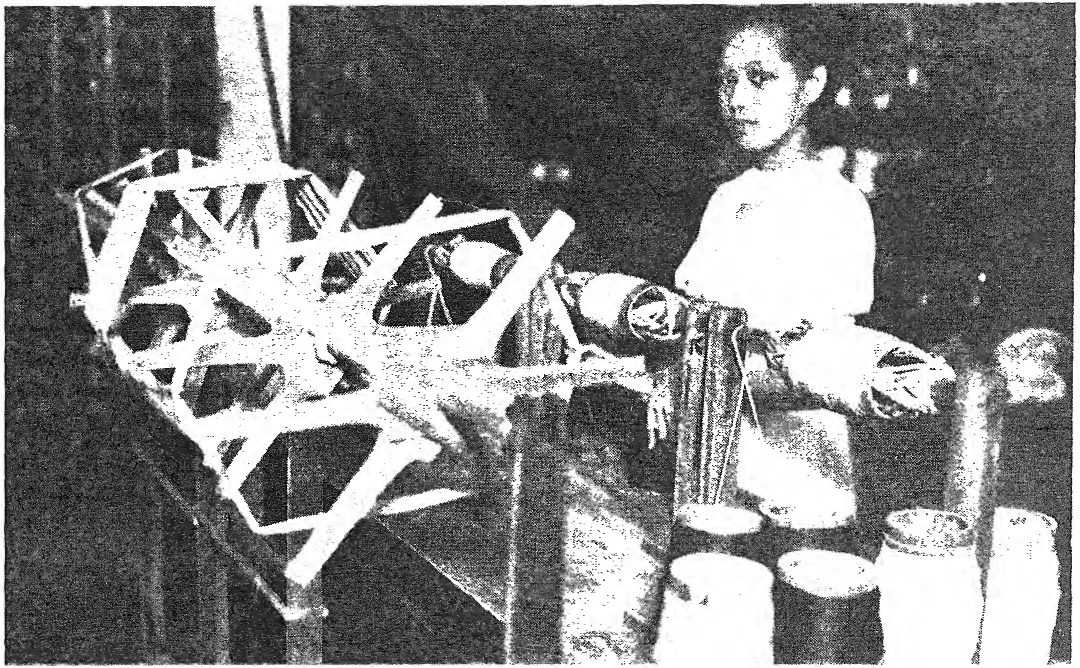

PLATE 8.

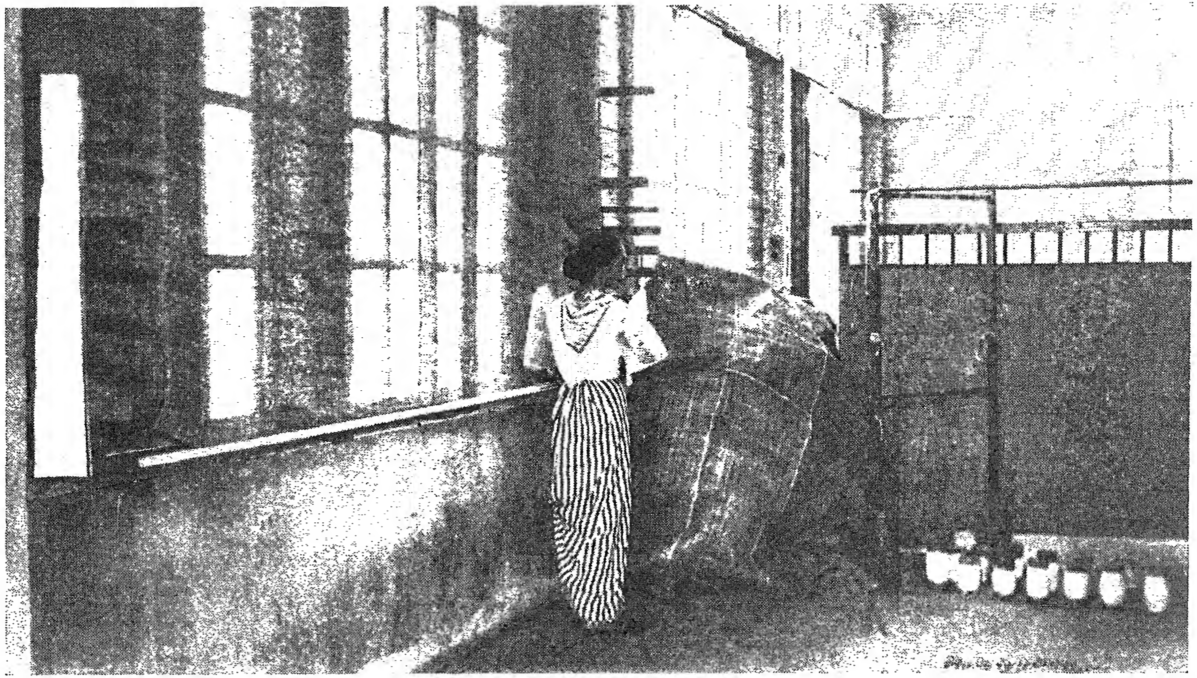

PLATE 9.

PLATE 10.

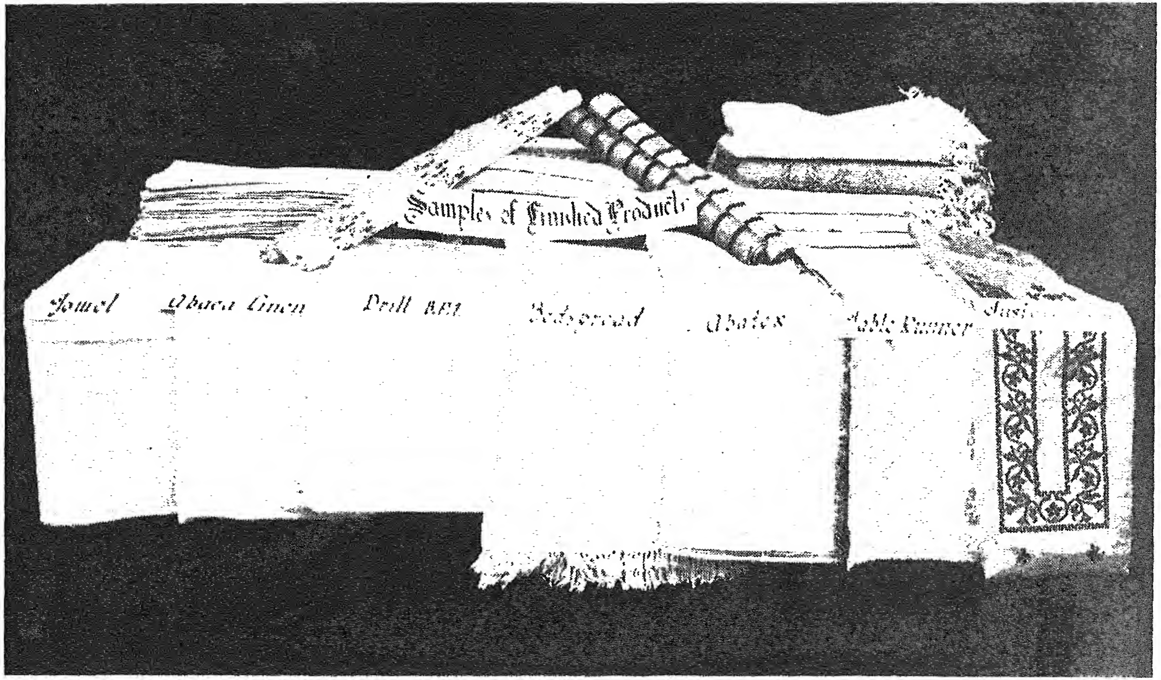
Samples of Finished Products
Towel
Abaca Linen
Drill
Table Runner

PLATE 11.

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# FURTHER STUDY OF THE INFLUENCE OF HEAT AND CARBON DIOXIDE ON THE DEVELOPMENT OF CARABAO MANGO BUDS

By F. G. GALANG and JULIAN A. AGATI
*Of the Horticulture Section*

TWO TEXT FIGURES

This paper gives the results of a further study of the influence of heat and smoke on the development of Carabao mango buds, *Mangifera indica* L., as published in the Philippine Journal of Agriculture, Vol. 7, No. 2, Second Quarter, 1936(2). In that paper it was reported that the development of the Carabao mango buds was accelerated with the application of carbon monoxide and carbon dioxide with heat in moderate amounts than with heat alone. The heat referred to here was liberated by the fire built under the trees, using charcoal as fuel. Thus, the heat produced was found to contain also a certain quantity of gases—carbon monoxide and carbon dioxide. Moreover, the smoke applied through a condenser carried also a certain amount of heat with the gases. In that experiment it was not quite possible to account separately the effects of cargon dioxide or other gas factors from the heat factor on the bud development of mango so that one may prove conclusively which one is responsible, the carbon dioxide or the heat, on the development of mango buds in smudging the trees. It was deemed necessary, therefore, to device means whereby a certain amount of heat could be

liberated alone without any accompanying smoke or gas; similarly, to obtain carbon dioxide apart from heat. To accomplish this, the use of an electric-heater and dry-ice was resorted to. The experiment under review had for its principal object the determination of the subsequent effects of heat produced by means of an electric heater and that of carbon dioxide liberated from dry-ice on the development of Carabao mango buds.

## MATERIALS AND METHODS

The experiment was started during the latter part of January, 1936 and lasted till the middle of April of the same year, or a total of 72 days of actual observation, excepting Sundays and holidays. The same plants previously experimented with were used in this experiment. They consisted of grafted Carabao mangos that had flowered already in petroleum cans. These were repotted in half-galvanized empty calcium arsenate drums, and were about 3½ to 4 years old. There were seventeen of them and consecutively numbered from 1 to 17. These plants were divided into lots; namely, the dry-ice lot, the electric-heater lot and the control lot. Each lot or group of plants was placed a few meters away from the other in order to prevent any possible contamination of the carbon dioxide or the heat which was to be applied. Originally, the first and the second lots consisted of 5 plants each—Nos. 1, 11, 12, 15 and 19, and Nos. 5, 6, 13, 14 and 17, respectively, and 7 plants—Nos. 2 to 4 and 7–10—of the control lot. However, to check further the effect of $CO_2$, the No. 5 and the No. 6 of the heated plants were transferred on March 10, 1936 to the dry-ice lot. At this time there was no apparent sign of bud activities on these plants.

In general a great majority of the plants looked healthy before the treatments were made. Although some of them had newly developed flushes, on the whole, the buds were good. The total number of twigs per tree in the dry-ice lot ranged from 11 to 38, and these twigs were from 4 to 337 days old. The plants heated with an electric current had twigs ranging from 5 to 28 and were from 29 to 337 days old, and the control plants from 10 to 43 twigs each and 27 to 337 days old.

During the experiment, the plants were watered regularly to keep the soil in every pail uniformly moist throughout. The temperatures on each lot were recorded hourly each day by hanging various thermometers on the branches of the individual plants. The amount of $CO_2$ added to the plants was de-

termined daily by the so-called gasometric method. In addition to these, weather observations were taken daily while the experiment was going on.

The $CO_2$ gas was applied to the plants by exposing daily about a kilo of dry-ice.[1] This block of dry-ice was wrapped with perforated Manila paper and suspended on a pole erected at the middle and a little higher than the plants in the chamber. The chamber was made of abacá cloth built around the plants so as to keep the $CO_2$ sufficiently long with the plants. A small tin shed was set up at the top of the pole in order to protect the dry-ice from rains and excessive heat. With this device, the block of dry-ice gradually and slowly melted thus emitting fumes of $CO_2$ gas among the leaves of the treated plants. Similarly, an abaca cloth chamber was also constructed around the heated plants. But to conserve the heat as much as possible this chamber was later on reinforced with cellophane papers.

The determination of $CO_2$ applied daily by gasometric method as formulated by the Association of Official Agricultural Chemists(1) has been followed by Mr. Juan N. Samson of the Chemistry Section, as follows:

*Reagents.*—For displacement solution, 100 grams of NaCl was dissolved in 350 cc. of $H_2O$. About one gram of $NaHCO_3$ and 2 cc. of methyl orange indicator and a sufficient amount of $H_2SO_4$ (1+5) to make just acidic were added. The solution was decidedly pink in color and was stirred until all $CO_2$ was removed. And for the absorption of $CO_2$, about 50 grams of NaOH was dissolved for every 150 cc. of $H_2O$.

*Apparatus.*—The apparatus used in the sampling and in the analysis of $CO_2$ is shown in Fig. 1. It consists first of glass bottle (A) of about 10 liters capacity containing displacement solution which was connected to a 3-liter bottle (B) by means of a glass and rubber tubings. This 3-liter bottle was provided with bent glass tubings of 0.6 cm. in diameter. This bottle was strictly air-tight. It is this part of the apparatus that was used for sampling, the details of which will be discussed under sampling. A 100 cc. graduated gas-measuring tube with two stop-cocks, one on each end, was connected at its lower end with a leveling bulb (E) containing displacement solution, and at its upper end was connected to the 3-

[1] The dry-ice was obtained free from the San Miguel Brewery, Manila through the courtesy of Dr. F. T. Adriano.

liter glass jar and to the absorption gas pipette (D) containing NaOH solutions.

*Sampling.*—In sampling the $CO_2$ gas, the 3-liter bottle outfit described above was first filled with the displacement solution from a stock bottle. Then the outfit was taken to the place of the experiment where the gas was to be collected. At the end of the glass tubing (a), while collecting the gas, another

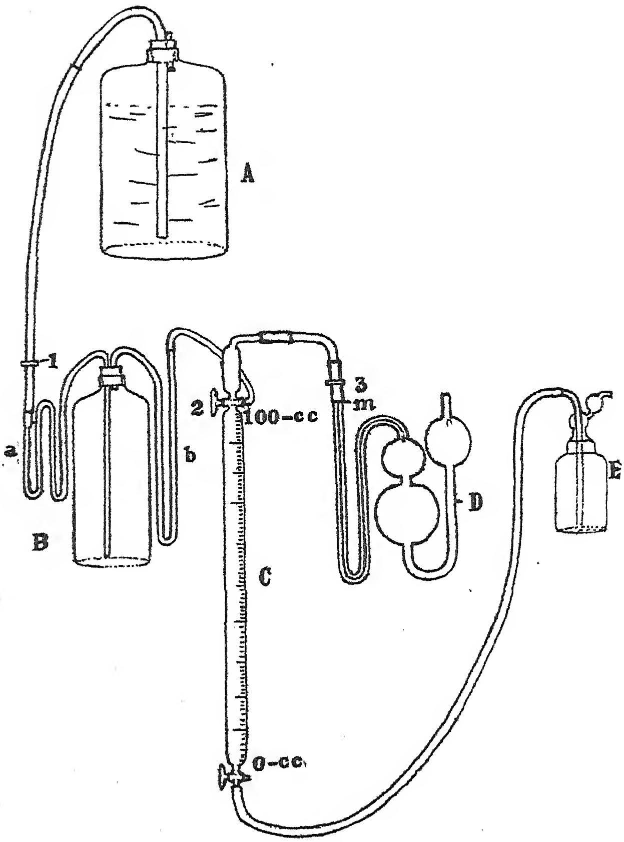



FIG. 1. Apparatus used in the sampling and in the analysis of $CO_2$ around the plants.

piece of glass tubing, about 1½ meters long and 0.9 centimeter in diameter was temporarily connected by means of rubber tubing. All the connections were made airtight to avoid any leak. In collecting the gas, the glass tubing which served as a sucking or inlet tube was inserted into the chamber of the plants to which $CO_2$ gas was being applied. As soon

as this was done the bottle containing the displacement solution was inverted and the solution was drained off slowly through (b) which was extended also by means of a rubber and glass tubings to reach a receptacle bottle temporarily placed on the ground to receive the displacement solution. In draining this solution the container was placed on a convenient stool and held firmly by means of an iron stand. This 3-liter bottle (B) as mentioned above served as an aspirator to receive the gas sample, which filled the vacuum created by draining the displacement solution from the bottle. The collection of gas from the chamber was done uniformly by moving the sucking or

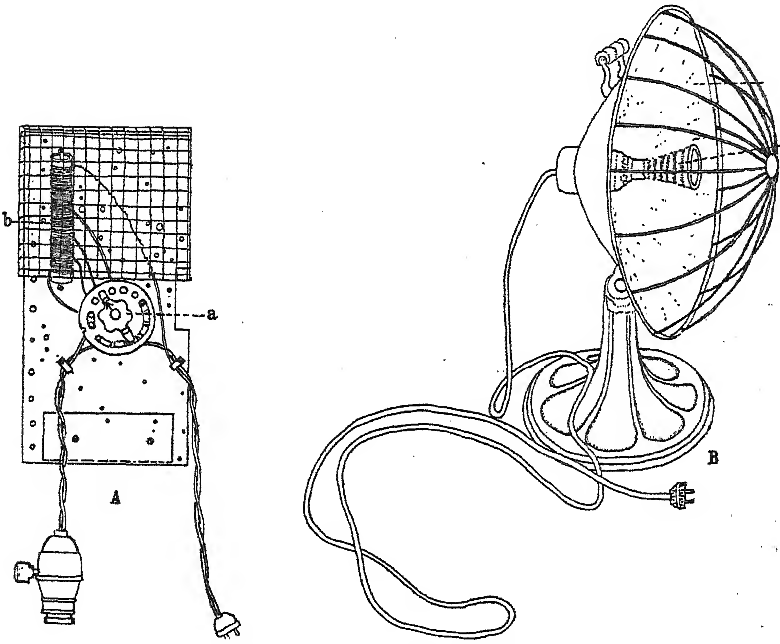



FIG. 2. Apparatus used for supplying heat to the plants.

inlet tube to the different parts of the chamber. When the displacement solution had been drained, the bottle containing the gas sample was brought to the laboratory and connected to the rest of the apparatus as in fig. 1, and the determination of the $CO_2$ gas was made accordingly.

*Determination.*—The graduated gas-measuring tube was filled with the displacement solution to the pinchcock which is to the 100-cc mark, by raising the leveling bulb. The displacement solution was allowed to flow from glass jar (A) to the bottle (B) containing the sample by opening pinch cock (1)

until the air in glass tubing (b) was expelled. The end of (b) was then connected to the pinch cock (2) of the gas-measuring tube by means of a rubber tubing. The leveling bulb was then lowered until the displacement solution in the gas-measuring tube reached the zero mark. The pinch cock was then closed and the rubber tubing was disconnected. In lowering the leveling bulb, vacuum was created, thus causing the suction of the gas sample into the gas-measuring tube. The level of the displacement solution in the gas-measuring tube and in the leveling bulb were brought to the same level and the pinch cock (2) was opened for about 5 seconds to equalize the pressure inside the gas-measuring tube with that of the atmosphere. The stop cock (2) was then opened and the leveling bulb was raised and lowered so that the displacement solution reached the 100-cc mark and O-mark of the gas-measuring tube. The raising and lowering were done three times. The NaOH in the absorption gas pipette was made to be in level at (m). The displacement solution in the leveling bulb and in the gas-measuring tube were brought to the same level, and the corresponding reading in the gas-measuring tube was read.

The heat was applied to the plants by means of an electric-heater, Empire type, 110 volts, and with a rheostat regulator to bring the heat up to 220 volts if necessary (see fig. 2). The rheostat regulator (a) served to regulate the heat, and the wire coils (b) for transmitting the electric current to the heat-reflector (c). This reflector consisted of a disc plate with wire coils (d) at the middle. These electrical instruments were connected with a switch.

To distribute the heat uniformly throughout the plants, a small, low-set table was provided for at the middle of the chamber and served as a stand for the heater. The plants were arranged around the heater in order to receive the heat as much as possible. Besides, the heat-reflector was changed toward the other directions from time to time. To protect the apparatus from rains, a movable galvanized iron roofing was provided for. However, this roofing was seldom used because of the prevailing good weather during the course of the experiment.

## RESULTS

The results of the experiment are shown in the following tables.

Of the 7 plants treated with dry-ice 6 responded which represented an average of 85.71 per cent. While of the heated plants only 20 per cent had produced new flushes, which result

was even lower than that of the control—28.57 per cent. Taking the trees as a whole, and with the exception of Tree No. 6 which was transferred from the heated chamber to this lot, they all produced new buds ranging from 13.33 to 100 per cent, or with an average of 68.41 per cent against 20 and 27.3 per cent of the heated plants and the control, respectively. The development of new buds took place in 23 to 70 days, or a total of about 157 to 401 hours application of carbon dioxide.

The air was enriched for about 5 to 6 hours daily with carbon dioxide ranging from 3.59 to 3.63 per cent by volume and applied mostly in the morning. The usual amount of carbon dioxide in the air around the premises varied from 0.02 to 0.03 per cent by volume, or 2 to 3 parts per 10,000 parts of air. The average daily temperature in the chamber was 31.08 °C or with an increase of 1.17°C over the air temperature of 29.9°C outside the chamber. This slight difference in temperature was perhaps due to the enclosure made around the plants. During the dry-ice application there were 48 bright and 22 cloudy days compared with 50 and 22 days of the heated and control plants. The age of the twigs varied from 4 to 337 days against 29 to 337 days of the heated plants and 27 to 337 days of the control.

As shown on Table II, the bud development of the plants heated with an electric current was so meager compared with the carbon dioxide and the control plants. For instance, only Tree No. 17 had produced new buds in about 209 hours distributed for 28 days. But at the time the tree was treated although it has 23 twigs, its condition was rather poor because its trunk sustained some physical injuries. In 1933, this plant had but one main branch with five newly developed twigs at the end. Under this condition it was but natural for this plant to send new growths for its sustenance irrespective of the treatment given to it. The other trees in spite of their normal growths and maturity of their twigs, which the minimum age averaged to 119 days and the oldest 310.8 days compared with 81.5 and 315.4 days of the plants subjected with carbon dioxide, did not produce any even after subjecting them with a temperature ranging from 3.1 to 5.7°C for about 6 hours daily, or an average of 4.14°C for 498.7 hours in 72 days. However, one of the trees—No. 5—when treated with carbon dioxide for about 157 hours in 27 days, 100 per cent of its twigs produced new buds. This indicates clearly the influence of carbon dioxide on the development of mango buds.

TABLE I.—*Showing the effect of $CO_2$ on carabao mango buds*

| Tree No. | Twig | | Weather | | Average daily temperature | | | Treatment | | Bud development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. per tree | Approximate age in days | No. of bright days | No. of cloudy days | Air (°C) | In the chamber (°C) | Difference (°C) | No. of hours | Pct. by volume of $CO_2$ per day | No. of days | No. of buds | Per cent |
| 1 | 38 | 4–302 | 46 | 21 | 30.2 | 31.5 | 1.3 | 401.30 | 3.62 | 67 | 36 | 94.07 |
| 5 [a] | 11 | 238–344 | 19 | 8 | 30.3 | 31.6 | 1.3 | 157.05 | 3.59 | 27 | 11 | 100.00 |
| 6 [a] | 28 | 139–337 | 23 | 9 | 29.9 | 31.1 | 1.2 | 186.50 | 3.61 | 32 | ------ | ------ |
| 11 | 15 | 137–337 | 48 | 22 | 29.2 | 30.5 | 1.3 | 436.60 | 3.63 | 70 | 2 | 13.33 |
| 12 | 13 | 16–337 | 29–39 | 9–11 | 29.1 | 30.6 | 1.5 | 302.20 | 3.62 | 38–50 | 12 | 92.30 |
| 15 | 13 | 32–337 | 17 | 10 | 30.5 | 31.2 | 0.7 | 193.00 | 3.62 | 27 | 13 | 100.00 |
| 19 | 24 | 5–214 | 15–18 | 8–10 | 30.2 | 31.1 | 0.9 | 193.00 | 3.62 | 23–28 | 19 | 79.16 |
| Total | 142 | 571–2208 | 210 | 91 | 209.4 | 217.6 | 8.2 | 1,869.65 | 25.31 | 301 | 93 | 478.86 |
| Average | 20.2 | 81.5–315.4 | 30 | 13 | 29.9 | 31.08 | 1.17 | 267.09 | 3.62 | 43 | 13.3 | 68.41 |

[a] These plants were previously treated with electric current.

TABLE II.—*Showing the effect of heat on the development of carabao mango buds*

| Tree No. | Twig | | Weather | | Average daily temperature | | | Treatment in Hours | Bud development | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. per tree | Approximate age in days | No. of bright days | No. of cloudy days | Air (°C) | In the chamber (°C) | Difference (°C) | | No. of days | No. of buds | Per cent |
| 5 | 11 | 238–344 | 27 | 13 | 29.6 | 33.3 | 3.7 | 266.25 | 40 | ------ | ------ |
| 6 | 28 | 139–337 | 27 | 13 | 29.6 | 33.3 | 3.7 | 266.25 | 40 | ------ | ------ |
| 13 | 5 | 91–238 | 50 | 22 | 30.3 | 36.0 | 5.7 | 498.70 | 72 | ------ | ------ |
| 14 | 15 | 98–298 | 50 | 22 | 30.0 | 34.5 | 4.5 | 498.70 | 72 | ------ | ------ |
| 17 [a] | 23 | 29–337 | 18 | 10 | 29.7 | 32.8 | 3.1 | 209.35 | 28 | 23 | 100 |
| Total | 82 | 595–1,554 | 172 | 80 | 149.2 | 169.9 | 20.7 | 1,739.25 | 252 | 23 | 100 |
| Average | 16.4 | 119–310.8 | 34.4 | 16 | 29.84 | 33.98 | 4.14 | 347.85 | 50.4 | 4.6 | 20 |

[a] The condition of the tree was rather poor.

TABLE III.—*Showing the behavior of the control plants*

| Tree No. | Twig | | Weather | | Bud development | | | |
|---|---|---|---|---|---|---|---|---|
| | No. per tree | Approximate age in days | No. of bright days | No. of cloudy days | Air temperature (°C) | No. of days | No. of buds | Per cent |
| 2 | 25 | 49–292 | 50 | 22 | 30.2 | 72 | | |
| 3 | 43 | 27–49 | 50 | 22 | 30.2 | 72 | | |
| 4 | 11 | 121–170 | 28–36 | 8–11 | 29.5 | 36–47 | 10 | 90.9 |
| 7 | 12 | 121–292 | 47 | 22 | 29.5 | 69 | 12 | 100.00 |
| 8 | 10 | 34–232 | 50 | 22 | 30.2 | 72 | | |
| 9 | 23 | 27–292 | 50 | 22 | 30.2 | 72 | | |
| 10 | 23 | 27–337 | 50 | 22 | 30.2 | 72 | | |
| Total | 147 | 406–1,664 | 333 | 143.0 | 210.0 | 476 | 22 | 190.9 |
| Average | 21 | 58–237.7 | 47.5 | 20.4 | 30.0 | 68 | 3.1 | 27.3 |

Of the 7 control plants, two sent new flushes but these trees were also in a very poor condition together with Tree No. 8 which remained dormant throughout the experiment. In 1933, Tree No. 7 produced only three shoots from its three weakened branches, while Tree No. 4 produced 5 new shoots in the same year from its two main but very defective branches. The air temperature around the plants averaged 30.0°C.

## SUMMARY

1. This experiment gives the comparative effect of carbon dioxide and heat on the development of the Carabao mango buds whereby the dry-ice was the source of the carbon dioxide and electric current for the heat.

2. The effect of the heat was not so striking as the carbon dioxide, which result was even lower than the control plants as regards the development of the buds.

3. The use of carbon dioxide showed the greatest bud development.

## LITERATURE

1. ANONYMOUS, 1930. Official and tentative methods of analysis of the Association of Official Agricultural Chemists 3*d* ed. v + 593 pp. Washington, D. C. Association of Official Agricultural Chemists.
2. GALANG, F. G. and JULIAN A. AGATI, 1936. A progress report on the influence of heat and smoke on the development of Carabao mango buds. The Phil. Jour. Agric. 7 (2): 245–261. Second Quarter.

## ILLUSTRATIONS

TEXT FIGURES

# PROGRESS REPORT ON STRAWBERRY TESTS AT BAGUIO, MOUNTAIN PROVINCE

By Mariano E. Gutierrez
*Of the Baguio Plant Industry Experiment Station*

## INTRODUCTION

Strawberry, *Fragaria chiloensis,* is one of those plants successfully introduced, which has become permanent in the Philippines. Being distinctly a temperature country plant, it thrives best in our cool highlands, like Baguio, Trinidad Valley, Mountain Province, and other high regions, above 2,000 feet elevation, where the climate is cool.

In general, in this country of adoption, it has partly lost some of its important and distinguishing characteristics at home, such as, ease of growth and culture, even growing in a wild state, luxuriance, heavy runner production, size of berries, shipping quality, and sweetness. The last two qualities, however, persist in a few of the varieties introduced.

Due to the above limitations, we cannot translate here in their entirety the successful cultural practices given to it at home. For a permanent foothold of strawberry in this country, it is eminently desirable to know its newly acquired habits and requirements in the new country. For example, due to abundant runner production, strawberry at home can stay productive for more than a year in the same ground. With partly losing this character in the Philippines, it has to be planted anew every year, otherwise no marketable berries can be harvested in the second year. Likewise, the matted row system of culture, taking advantage of the runner production, cannot be followed in this country.(1, 2).

Producing strawberries successfully here presupposes a series of long and continued trials such as introduction and adaptability tests of all available good varieties and novelties from different countries, variety tests, seasonal planting, cultural methods, spacings, planting material tests, fertilization, breeding, etc., so that a combination of the best findings in these experiments may evolve a good system of profitable culture

in the new country of adoption. Often with a new crop our farm practices are empirical, because of newness or borrowed unchanged from the practices abroad. What is said of its culture applies also to the absolute reliance on varieties found best in certain countries and their introduction, expecting that these varieties will duplicate their performance here.

Strawberry, praised highly by Doctor Boteler (3) with the oft-quoted statement: "Doubtless God could make a better berry, but doubtless God never did," ranks foremost as a table delicacy among the vegetables and fruits grown but of imported origin in Baguio. With Americans and Europeans, strawberries are eaten as a matter of course; with us Filipinos, strawberries like cauliflower and avocados, come under the class of new foods, requiring cultivated taste. Being a good food, our compatriots not only relish it now in its fresh or preserved state but is the gift (*regalo* or *pasalubong*) *par excellence* to loved ones, or friends. Flowers being common everywhere it is more forceful to say it with Baguio strawberries. So it is, that during the summer in Baguio, production is insufficient to meet the ever-growing demand of this attractive, fragrant, and luscious berry. Hectarage may be doubled, nay, trebled, and yet the supply will be inadequate. The proper culture of strawberries, therefore, is fraught with great possibilities.

Strawberry is the main crop of the Baguio Plant Industry Experiment Station and has acquired an enviable reputation for cleanliness, sweetness, and quality. It is rated by Americans and Europeans as the best the Baguio trade could offer. This may be attributed to the fact that the accumulated knowledge acquired from our tests are put into practice in our field culture. Coöperators, like Mr. Jesus Cacho in his Paraiso Plantation at Yagyagan, Sablan, who follow our method of culture and plant the specific varieties recommended to them, can produce berries ranking next to the station's.

The following pages report the progress mostly of first year results of strawberry tests, and recapitulates the three-year fertilizer tests in connection with a new fertilizer experiment. They are presented here with the view of recording the facts thus far found, which may need further verification or corroboration in future repeated tests in order to arrive at more conclusive truths and to serve as a guide in strawberry culture.

In order to get the gist of these findings, after the exposition of facts borne by these various subjects treated, they will be col-

lected and presented at the end of this report in a succinct summary. In the light of our present knowledge gained thus far from these experiments, they are recommended in the interim to commercial strawberry growers, whose farms have similar conditions as the Baguio Plant Industry Experiment Station.

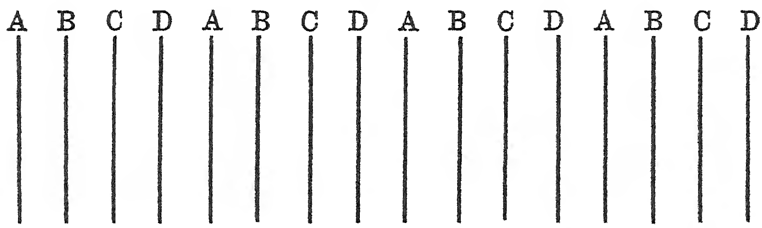
## GENERAL STATEMENT OF SIMILAR OPERATIONS COMMON WITH THE TESTS UNDER REVIEW

In order to avoid useless repetitions of the same facts in every test, the following general statement of operations, which were identically the same in different tests are mentioned. Any variation from these will be stated for each test.

*Time and place.*—With the exception of two earlier tests, these tests were conducted in the strawberry season of 1936–37, all at the Baguio Plant Industry Experiment Station, Baguio, Philippines.

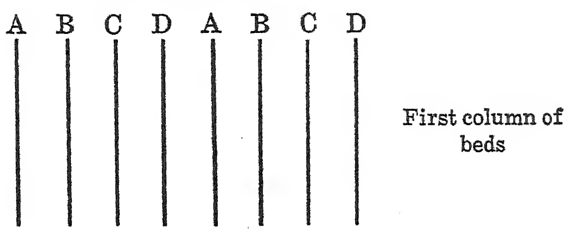
*Beds and arrangement of replications.*—Our standard beds were 1.2 m. wide, permitting three rows of strawberry plants set in triangles, spaced 30 cm. between plants. When these beds ran throughout the length of the field, the replicated beds or plots were arranged as follows:

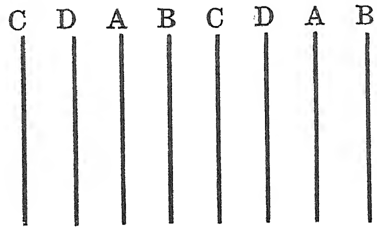
*Arrangement I*




When the beds were short, permitting two columns of beds in the field, the replications were arranged as follows:

*Arrangement II*






Second column
of beds

*Land conditions.*—For each experiment, efforts were made to use land with fairly uniform conditions as to fertility, topography, exposure, soil, etc.

*Planting materials used and treatments.*—With the exception of certain tests, the planting materials used were the old strawberry clumps, washed, conveniently divided into sets, cleaned of dry and old leaves, branches and old roots cut off. As our fields were previously infested by strawberry thrips, the cleaned plants were soaked for 5 minutes in a solution of Imazu (70 grams) and soft soap (80 grams) dissolved in 20 liters of water.

*Mulching material.*—Unless otherwise stated, the mulching material used was a mixture of pine needles and the cut grasses growing below the pine trees. The mulch was applied after the second application of fertilizers.

*Rate and method of fertilizer application.*—The fertilizer was applied at the rate of one (1) ton per hectare. Fractional application was resorted to: one-half of the amount at planting time, placed in each hole and mixed with earth before setting the plants or shortly thereafter by scattering the fertilizer close to the plants and the earth stirred with the hand cultivator. The second half of the fertilizer was applied when the plants were about to bloom and was immediately followed by the mulch.

*The area per bed.*—In all these tests, the corresponding 40 cm. wide path alongside each bed was included in the area of every bed, in order to include these blank or dead spaces in the field and get the correct yield, as the paths are parts of the field planted and necessary for operations.

*Frequency of picking berries and manner of recording yields.*—Picking of berries was done thrice a week: Mondays, Wednesdays, and Saturdays. The yield per plot was separately picked and placed in paper bags, properly labelled to correspond to the plot number. These were weighed separately and then recorded in the Strawberry Book at the office. Picking was continued from 3 to 5 months, or until the yield per plot was so low as

to justify separate weighing. The total yield for each replicated plot or bed are given in the different tables of results.

## I. ADAPTABILITY TESTS OF STRAWBERRY VARIETIES

Ever since this station started planting strawberry, it has continuously carried on adaptability tests. Some 31 introductions, consisting of 26 varieties, have been tested. A few of them gave very successful results and now supply planting materials for our cultures. Others are gradually being adapted and in process of multiplication. Many of the varieties are indifferent and a few of these are affected by disease and are to be discarded. Other varieties could not stand the conditions and therefore gradually died out, without even a living representative to show their existence.

For a better understanding of the extent of these introductions and the kinds of varieties tried, the following list was obtained from our records, showing P. I. numbers, variety, origin, and

TABLE 1.—*Showing a list of strawberry varieties from different sources introduced into this station for the decade 1926–1936*

| P. I. No. | Variety name | Origin | Date of introduction |
|---|---|---|---|
| 9,773 | Wilson | Trinidad Valley | Dec. 16, 1926. |
| 9,552 | *Fragaria* sp | U. S. Dept. of Agriculture | Nov. 4, 1927. |
| 9,789 | Ecuador | United States | Mar. 10, 1928. |
| 10,352 | F. *chiloensis* | Poona, India | Dec. 19, 1930. |
| | Hood River | Trinidad Valley | Jan. 5, 1931. |
| 10,501 | Large Red Alpine | Reading, England | Aug. 25, 1931. |
| 10,502 | Royal Sovereign | Reading, England | Aug. 25, 1931. |
| 10,746 | Big Joe | Geneva, O. U. S. A. | Feb. 18, 1931. |
| | Missionary | United States | Aug. 4, 1931. |
| | Klondyke | Florida, U. S. A. | Aug. 4, 1931. |
| | Blakemore | Florida, U. S. A. | Jan. 26, 1932. |
| | Howard 17 | United States | Jan. 26, 1932. |
| | Missionary | United States | Feb. 27, 1932. |
| 12,246 | Southland | Michigan, U. S. A. | December 21, 1933. |
| 12,247 | Fairfax | Michigan, U. S. A. | December 21, 1933. |
| 12,248 | Dorsett | Michigan, U. S. A. | December 21, 1933. |
| 12,249 | Bellmar | Michigan, U. S. A. | December 21, 1933. |
| 12,250 | Super Giant | Michigan, U. S. A. | December 21, 1933. |
| 12,251 | Mastodon | Michigan, U. S. A. | December 21, 1933. |
| 13,252 | Big Joe | Michigan, U. S. A. | December 21, 1933. |
| 12,253 | Chesapeake | Michigan, U. S. A. | December 21, 1933. |
| | Aroma | Lipa, origin U. S. A. | April 6, 1936. |
| | Fairfax | Lipa, origin U. S. A. | April 6, 1936. |
| | Narcissa | Lipa, origin U. S. A. | April 6, 1936. |
| | Clermont | Lipa, origin U. S. A. | April 6, 1936. |
| | Camden | Lipa, origin U. S. A. | April 6, 1936. |
| | Dorsett | Lipa, origin U. S. A. | April 6, 1936. |
| | Mastodon | Lipa, origin U. S. A. | April 6, 1936. |
| | Pearl | Lipa, origin U. S. A. | April 6, 1936. |
| | California, no variety name | Baguio, Mountain Province | September 7, 1936. |
| | New Zealand | Baguio, Mountain Province | September 7, 1936. |

approximate date of introduction. It can be seen that a variety may have been introduced twice.

Of the early introductions, Hood River and Wilson varieties were found to be the best adapted to our conditions and at present constitute our large experimental and commercial cultures.(4) Hood River has large berries, obcordate in shape, subacid, and soft of flesh. It does not have a good shipping quality. The plants are of fair height, and the leaves are large and light green. It has lost its runner production under our conditions. The greater part of our cultures is of this variety.

The Wilson has elongate and tapering berries, and is slightly sweeter than the Hood River. It has slightly better shipping quality than the former. Between the two, there is not much difference in vegetative appearance.

Missionary comes third as the successful introductions. The vegetative growth is not as dense as the first two and of slightly lighter color. It has the unique distinction of not losing the home characteristic of producing profuse runners. The principal objection to its berries is their sour taste, but their flesh is firm, an indication of good shipping quality. Superintendent José de Leon of Lipa Coffee–Citrus Experiment Station stated to the writer in February, 1937 that this variety is adapted to the Lipa altitude of 1,000 feet.

Klondyke is gradually being adapted; the berries are objectionable for being also sour. It is a shy bearer.

Dorsett, Big Joe, Mastodon, Bellmar, and Fairfax show fair adaptability. Dorsett and Fairfax were bred by the United States Department of Agriculture. Both have good shipping quality, but Fairfax turns out sweeter berries than Dorsett.

Chesapeake, Blakemore, and Howard 17 show poor adaptability, especially the last two. Blakemore is affected with chlorosis, which may be the symptom of mosaic.

Ecuador is poor, seriously affected with very pronounced leaf spots, and should be discarded.

Of the introductions made in 1936, Narcissa is considered the best. This variety has heart-shaped dark red berries, very sweet, with firm red flesh and of good shipping quality. It is the largest plant among the new introductions. Observations show that after the fruiting season, Narcissa stands out prominently as one with luxuriant foliage and show little signs of being stunted as the other introductions grown side by side with it. It is also the least affected by diseases and pests. Nar-

cissa shows great promise and may yet surpass either the Hood River or the Wilson.

Clermont and Aroma, next to Narcissa, in the order named, are well adapted. Canden is fairly well adapted.

The second introduction of Fairfax and Dorsett show fair adaptability.

Mastodon and Pearl are poor.

The California and New Zealand varieties show good adaptability, although the berries of both are small. The New Zealand has sweeter berries than the California variety.

In general, the recent introductions that are doing well have darker and smaller leaves than the Hood River. They are low and compact.

## II. ROOTED VERSUS UNROOTED STRAWBERRY PLANTING MATERIALS

*Object.*—The object of these tests was to compare on a fairly large scale the behavior of rooted plants, previously grown in the nursery, with ordinary plants taken from the old strawberry fields. Which of the two planting materials yields earlier and more berries?

*Materials and methods.*—Hood River strawberry ordinary planting materials were planted in seedbeds, spaced 15 cm. apart each way, from May 29 to June 6, 1936. These plants were planted in the same manner as our ordinary field planting, except in the very close spacings.

After two and one-half months in the nursery, the plants were carefully taken out with all the young roots and part of the earth adhering and were set in one-half of our field of 470 sq. m. or 235 sq. m., known as Plot A, consisting of 7 beds. The second half of the field, Plot B, also of 7 beds, was simultaneously planted with plants from the old fields, cleaned, conveniently divided, and disinfected. Before planting these plots, compost at the rate of one petroleum canful for every 1.2 sq. m. was applied to all the 14 beds. Subsequent treatments of these two plots, such as weeding, spraying, mulching, fertilizing with ammophos plus sulphate of potash, and watering were uniform.

*Observations.*—Plot A with the nursery plants showed better vegetative development than those of Plot B with the ordinary planting material. Plot A also showed earlier tendency in blooming and bearing. On November 23, 1936, the first harvest of marketable berries was made from Plot A, while from Plot

B, the first harvest was made on November 30, one week later. Picking of berries in both plots ended on April 17, 1937, or a period of nearly 5 months. In every harvest, the yield of Plot A was consistently greater than the amount of berries picked from Plot B. As it would occupy too much space to present the whole period comprehended in the harvest, the above fact could be easily seen by reproducing part of this harvesting period, from December 16, 1936 to January 30, 1937, or a period of 1½ months only.

TABLE 2.—*Showing the amount of berries in kilos picked simultaneously at regular intervals from each plot, and the difference always in favor of Plot A.*

| Date of harvest | Yield in kilos of berries | | Difference in favor of Plot A |
|---|---|---|---|
| | Plot A | Plot B | |
| | | | *kilos* |
| December 16, 1936 | 1.60 | 0.36 | 1.24 |
| December 19, 1936 | 3.00 | 0.86 | 2.14 |
| December 21, 1936 | 2.40 | 0.56 | 1.84 |
| December 23, 1936 | 3.00 | 1.20 | 1.80 |
| December 26, 1936 | 4.40 | 1.60 | 2.80 |
| December 28, 1936 | 3.00 | 0.78 | 2.22 |
| December 30, 1936 | 3.20 | 1.40 | 1.80 |
| January 2, 1937 | 4.60 | 2.20 | 2.40 |
| January 4, 1937 | 4.20 | 1.60 | 2.60 |
| January 6, 1930 | 4.00 | 1.60 | 2.40 |
| January 9, 1937 | 5.40 | 2.20 | 3.20 |
| January 11, 1937 | 4.00 | 1.80 | 2.20 |
| January 13, 1937 | 2.80 | 1.40 | 1.40 |
| January 16, 1937 | 6.00 | 2.80 | 3.20 |
| January 18, 1937 | 2.60 | 1.00 | 1.60 |
| January 20, 1937 | 3.80 | 1.20 | 2.60 |
| January 23, 1937 | 3.80 | 2.20 | 1.60 |
| January 25, 1937 | 2.60 | 1.40 | 1.20 |
| January 27, 1937 | 2.00 | 1.60 | 0.40 |
| January 30, 1937 | 3.00 | 2.00 | 1.00 |
| etc., etc. | | | |

For the entire harvesting period, the total yield from Plot A was 147.aould''os or a calculated yield of 6268.1 kilos per hectare, while duot B yielded 70.42 kilos or a calculated yield of only 2996.6 kilos per hectare.

*Summary.*—The rooted strawberry planting material consistently produced greater amount of berries at every picking day and yielded marketable berries earlier than the unrooted planting material, thus prolonging the period of harvest. The nursery planting material more than doubled the total yield obtained from the plot with the ordinary planting material.

These tests may be repeated next season, but will be included in the planting materials tests, the first season results of which follow.

### III. TESTS OF DIFFERENT STRAWBERRY PLANTING MATERIALS

*Object.*—To test the productive efficiency of different planting materials. Which is the most productive, plants, runners, or seedlings?

*Materials and methods.*—The fairly uniform field chosen for these tests was divided into 12 beds with an area of 16 sq. m. each.

The different variables were:

A. Plants from old clumps (clons).
B. Runners, rooted plantlets from runners.
C. Seedling plants, unselected grown one season ahead from seeds.

Only the variety Wilson supplied all the above planting materials.

The plots of the different variables were replicated four times and the beds were laid out as per Arrangement 11.

With the exception of the varying planting materials, the beds were given uniform treatments, as to the amount and kind of fertilizer, being ammophos plus sulphate of potash, cultivation, spraying, watering, etc.

Planting was carried out during the last week of August, 1936. Mulching was completed in October of the same year.

*Observations.*—Of the different planting materials, the runners showed the best vegetative growth and were the tallest, followed by the seedlings. The seedlings, however, were not uniform, due to the fact that they did not come from a pure seedling strain for lack of the material. The plants showed the poorest vegetative development. The seedlings showed the earliest tendency to bear berries, which fact was noticed on October 8, 1936. There were more berries noted with the seedlings than any of the two other planting materials, although the size of the berries was very variable. On the other hand, the berries from the plants and runners were more uniform in size.

*Results.*—Picking of the berries under these tests was started on November 28, 1936 and ended on March 24, 1937,—a period of about 4 months. The results may be seen in the following table.

TABLE 3.—*Showing the yields of the different replicated beds, the average yields of the three variables, and the calculated yield per hectare of the plants, runners, and seedlings.*

| Plants | | Runners | | Seedlings | |
|---|---|---|---|---|---|
| Plot No. | Yield in kilos | Plot No. | Yield in kilos | Plot No. | Yield in kilos |
| 1–A | 1.67 | 1–B | 3.94 | 3–C | 4.78 |
| 4–A | 4.78 | 5–B | 4.25 | 6–C | 4.16 |
| 7–A | 5.35 | 8–B | 5.24 | 9–C | 7.04 |
| 10–A | 7.20 | 11–B | 4.82 | 12–C | 7.24 |
| Total yield | 19.00 | | 18.25 | | 23.22 |
| Average per plot | 4.75 ±0.287 | | 4.56 ±0.576 | | 5.80 ±0.287 |
| Calculated per hectare | 2,968.7 | | 2,850.0 | | 3,625.0 |

*Interpretation of results.*—In accordance with the above results, the seedling plants outyielded both the runners and the plants, the latter coming second. With the runners the luxuriant vegetative development was made at the expense of berry production. The difference, however, between the average yields of the plants and the runners per plot is very slight and it may be considered insignificant. This slight difference between the two is to be expected, as for practical purposes, the materials are of the same character, being clons or asexual parts of the same plants. The performance of the unselected seedlings used in these tests is of far reaching consequence and is indicated as a method for improving both the adapted and the recalcitrant varieties. In this connection, it should be borne in mind that practically all of our existing varieties were imported as plants, highly bred and adapted from whence they came. As a general practice here the increased propagation of the plants was made from plants, rarely from runners for want of same, and never from seeds. So that in our yearly repeated plantings, no change has been made of the planting materials and consequently of the adaptability or hereditary quality of the plants to the new set of conditions.

Were the seedlings used of pure strain, the yield registered would be still greater.

As strawberry varieties may be cross-pollinated by agency of insects or by the wind, it can be granted as one possible reason for this heavier yield, that some of the seedlings were first generation hybrids, exhibiting heterosis; although the fact of hybridity may not be general as the seeds were gathered from separate cultures of the varieties.

*Summary.*—From the above initial results, it may be tentatively concluded that seedlings are better yielding planting materials than either the plants or the runners, both being clons of the original imported plants. Were there any productive pure strain of Wilson available for these tests to supplant the mixed population used, the yield would be still greater.

## IV. STRAWBERRY SEEDLING AND SELECTION TESTS

*Object.*—The objects of these tests are to produce better adapted strains to Baguio conditions than their parents and to isolate productive or other strains with desirable qualities.

*Materials and methods.*—During the strawberry season of 1934–35, seeds of the following varieties were collected separately namely, P. I. 9773 Wilson, P. I. Missionary, P. I. 10,746 Big Joe, P. I. 12,249 Bellmar, P. I. 12,247 Fairfax, and P. I. 12,251 Mastodon.

Seeds were sown in seedflats on August 22, 1935. In November of the same year, the seedlings were pricked in partially shaded beds.

During February 12 to March 5, 1936, the different varieties were transplanted in separate beds for observation and propagation. From these plantings selections of the best looking plants were made. Our 101 selected plants were as follows:

| | | |
|---|---|---|
| Wilson | 25 strains | (Wi–1–25) |
| Missionary | 25 strains | (Mis 1–25) |
| Mastodon | 25 strains | (Mdn 1–25) |
| Bellmar | 11 strains | (Bel 1–11) |
| Big Joe | 10 strains | (BJ 1–10) |
| Fairfax | 5 strains | (Ff 1–5) |

Beds, 1.5 m. wide, were prepared for planting separately these strains, in order to give sufficient room for the strains to be planted in transverse order in the beds. Planting was made on August 7, 1936. As we were depending on the available planting material from single seedling mother plants, with varying number of suckers and runners, the planting materials from each mother plant naturally varied from a few to 54, the last indicating profuse runners. These were planted for observation and multiplication, in order to select further the very best, and later to be planted in test rows for comparison of possibilities.

Periodically these strain cultures were examined and studied. Separate record was made of each strain noting the outstanding characters. Sampling of the berries was made periodically in order to determine their shipping and eating qualities, especial-

ly with regard to firmness of flesh and the taste whether sour, subacid, or sweet.

The different strains of each variety manifested wide variability in the different characters. These variations were seen in the vigor and luxuriance of the plants, height, runner propensity, size of leaves, shape and size of berries, softness and firmness of flesh of the ripe berries, and the eating quality. Some of the strains of certain varieties exhibited different degrees of acidity from very sour to sweet. These wide variations were very favorable indeed for selection work. In general, the plants belonging to each strain were very uniform in their characters.

After a series of thorough observations, the following strains were finally picked out and marked for plant-to-the-row tests for the next season:

*P. I. 9773 Wilson*

| Strain No. | Selected for |
|---|---|
| Wi-3 | Robustness and large elongate berries. |
| Wi-5 | Robustness and earliness. |
| Wi-11 | Robustness. |
| Wi-14 | Sweetness. |
| Wi-18 | Size and sweetness; productiveness. |
| Wi-19 | Productiveness. |
| Wi-22 | Robustness and productiveness. |

*P. I. 9773 Missionary*

| | |
|---|---|
| Mis-2 | Robustness. |
| Mis-7 | Sweetness. |
| Mis-8 | Sweetness. |
| Mis-9 | Runner production. |
| Mis-13 | Robustness and size of berries. |
| Mis-17 | Sweetness, size of berries, and shipping quality. |
| Mis-19 | Robustness and sweetness. |
| Mis-23 | Sweetness and size of berries. |

*P. I. 12,251 Mastodon*

| | |
|---|---|
| Mdn-4 | Productiveness. |
| Mdn-6 | Robustness. |
| Mdn-8 | Shipping quality. |
| Mdn-13 | Productiveness. |
| Mdn-14 | Robustness. |
| Mdn-15 | Size of berries and shipping quality. |
| Mdn-17 | Sweetness and size of berries. |

*P. I. 12,249 Bellmar*

| | |
|---|---|
| Bel-1 | Size of berries. |
| Bel-3 | Productiveness, size of berries, and shipping quality. |
| Bel-8 | Elongate berries. |
| Bel-11 | Uniformity and robustness. |

*P. I. 10,746 Big Joe*

| | |
|---|---|
| BJ-8 | Productiveness. |
| BJ-10 | Size of berries. |

*P. I. 12,247 Fairfax*

| | |
|---|---|
| Ff-1 | Adaptability. |
| Ff-2 | Sweetness and shipping quality. |
| Ff-3 | Robustness. |

It is quite premature to state definite facts about these seedling selections. It is desirable to plant them in test rows with the original asexually propagated plants as checks.

Since all our fields of strawberry were the result of continuous asexual propagation from plants highly adapted and bred from the countries of origin, we have not made any change in their reaction to the new environment. Since a plant is both a product of heredity and environment,(5) it would seem that sexual propagation by the use of seeds will make a change in the resulting plants. In our tests just described, comparing seedlings with asexual materials, we found that the seedlings were more productive than the clons, which proves our contention. We may grant that some of the seedling plants are first generation hybrids, due to occasional cross fertilization in the field and exhibit heterosis or hybrid vigor. For continuous asexual propagation of these hybrid seedings, they will remain always first generation hybrids, exhibiting the desirable hybrid vigor, which will be for the better.

It is believed that with sexual propagation, the new environment may have been impressed in the seeds, or the adaptability to the new set of conditions could be obtained more readily by the use of seedling material than with the asexually propagated material for several years. The great variability exhibited by these seedlings, the recovery of certain characters or the attaining of new ones,—all prove that improvement in several characters may be obtained by the rigid selection of the best seedlings of these varieties.

For improving our different varieties, exhibiting poor or fair adaptability to our conditions, this method of propagation opens untold possibilities. We may mention one fact noted in our seeding selection work. The variety Missionary has consistently produced sour berries for seven years here. This variety is remarkable in retaining the character of runner production and the fact that it is the only variety, thus far found, which does well in much lower altitude than Baguio, at the

Lipa Coffee–Citrus Experiment Station, 1,000 feet above sea level. Two seedling strains, Mis–7 and Mis–8, produce sweet berries, which is a drastic departure from the sour taste of the berries from asexually propagated material.

### V. PINE NEEDLE COMPOST VERSUS ORDINARY COMPOST FOR STRAWBERRY

When the writer took charge of the station, two years ago, pine needles were used exclusively for mulching strawberries. This is because it is the most abundant local material for the purpose and the only expense involved is the gathering of same in our pine forest. It had been also the invariable practice that this partly composted pine needles on the beds were buried under in the preparation of the field for another crop. A part of a field similarly managed and then planted to strawberry a second time gave no yield of marketable berries. Subsequent treatments of the beds with different kinds of fertilizers, lime, ashes, etc., gave no improvement on yield, except foliage appearance. It was then suspected that the decomposed pine needle mulch of the previous strawberry crop, incorporated into the soil, may be inimical to the normal production of berries. To confirm or disprove this suspicion, it was necessary to subject this to an experimental test.

*Object.*—The object of these tests was to determine the effect of pine needle compost in comparison with ordinary compost and no compost application on the yield of berries.

*Materials and methods.*—A field, which was never planted to strawberry, and therefore free from pine needles, was selected for these tests. This field was previously planted to sweet potatoes, and just previous to these tests, with tomatoes. It was divided into 12 beds of an area of 40 sq. m. each.

The different variables or treatments were:

A. Pine needle compost, applied at the rate of one petroleum canful for 1.2 sq. m.

B. Ordinary compost (of grasses, animal manure and crop residues, mixed), at the same rate as A.

C. Check. No compost application.

The beds were replicated four times and were laid out as per Arrangement 1.

All the beds were fertilized with Station Mixture No. 2 (10 N–8 $P_2O_5$–6 $K_2O$) at the rate of one ton per hectare. The first half of the fertilizer was applied at planting time, while the second half was applied on August 5, 1936.

The variety used was the Hood River, which was planted on June 24, 1936.

On August 8 of the same year, the beds were uniformly mulched with dried reeds, instead of the usual pine needles. Reeds were used as the mulching material in order to forestall the effect, if any, of pine needle mulch.

Due to the initial infestation of small yellow spotted beetles on the leaves, all the beds were uniformly sprayed with 0.75 per cent of lead arsenate and soap solution (150 grams of lead arsenate and 50 grams of soap in 20 liters of water). The infestation was put under control.

*Observations.*—Ocular observation of the strawberry plants with the different treatments was periodically made. The beds with the ordinary compost application showed the best development, followed by the check beds. The beds with the pine needle compost application showed the poorest development. The appearance and size of berries of the compost (ordinary) and the check beds were normal; the berries with the pine needle compost were smaller and less in number.

*Results.*—Picking of berries was made at regular intervals, beginning on October 26, 1936 and terminating on January 30, 1937. The yields of the different replicated beds may be summarized in the following table.

TABLE 4.—*Showing the yields of berries in kilos of the different replicated beds of the three treatments, the average yield per bed of each variable, the calculated yield per hectare, the difference of yield against pine needle compost, and the value thereof.*

| Pine needle compost | | Ordinary compost | | Check. No compost | |
|---|---|---|---|---|---|
| Plot No. | Yield in kilos | Plot No. | Yield in kilos | Plot No. | Yield in kilos |
| 1–A | 7.35 | 2–B | 11.21 | 3–C | 8.31 |
| 4–A | 5.70 | 5–B | 9.44 | 6–C | 7.09 |
| 7–A | 6.55 | 8–B | 11.67 | 9–C | 9.96 |
| 10–A | 8.45 | 11–B | 9.34 | 12–C | 9.61 |
| Total | 28.05 | | 41.66 | | 34.97 |
| Average per bed | 7.012±0.438 | | 10.415±0.289 | | 8.742±0.289 |
| Calculated yield per Hectare | 1,753.0 | | 2,603.7 | | 2,185.5 |
| Difference against pine needle compost | | | 850.7 | | 432.5 |
| Value of difference at ₱0.30 per kilo | | | ₱255.21 | | ₱129.75 |

*Interpretation of results.*—Taking the calculated yield per hectare of the three treatments, as a basis for comparison, it can be readily seen that the pine needle compost yielded 432.5 kilos of berries below the check, and 850.7 kilos below the or-

dinary compost. The appreciable reduction of yield registered by the pine needle compost was very great, in spite of the fact that all the variables under comparison received the same amount of fertilizer, showing that the bad effect of pine needle compost for strawberry transcended the good effect of the fertilizer. When we value these differences, we find a loss of ₱129.75 per hectare for the use of pine needle compost in comparison with the check, and a greater loss of ₱255.21 in comparison with the use of ordinary compost. The difference between these two amounts must be definitely attributed to the complementary good effect of ordinary compost for strawberry in conjunction with the fertilizer.

*Summary.*—Pine needle compost for strawberry is decidedly inimical to the proper production of berries. The evil effect of pine needle compost to strawberry transcended the good effect of the fertilizer used. The use of ordinary compost further augmented berry yield, beyond the increase registered by the use of commercial fertilizer alone. It is better to use no compost at all than using the readily available pine needle compost.

## VI. STRAWBERRY MULCHING TESTS

*Object.*—The object of these tests was to determine the effect on yield of strawberry with three different kinds of mulching materials; namely, pine needles, reeds, and straw, especially the first as a complement of the previous tests.

*Materials and methods.*—For these tests, a field was selected, which was previously planted to sweet corn interplanted with beans. It was divided into 12 standard beds of 45 sq. m. each.

The different variables or treatments were:

A. Pine needle mulch.
B. Reed mulch.
C. Straw mulch.
D. Earth mulch (check).

The variables were replicated three times, with the different beds laid out as Arrangement 1.

On June 26, 1936, ordinary compost was applied at the same amount per bed. Three days after, on June 29, the variety Hood River was planted in the beds.

One-half of the amount of Station Mixture No. 1 fertilizer was applied on August 5, while the second half was applied on September 17, 1936. After the second application, the different mulching materials were placed uniformly on their respective beds.

All the beds were uniformly sprayed with lead arsenate and soap on September 19, 1936.

*Observations.*—Early in October, the check beds with the earth mulch produced berries ahead of the other variables. Here and there among the different treatments berries were also noted, but not as great a proportion as in the check beds. On the whole, there was no marked difference in the foliage development of the different variables.

*Results.*—Harvest of the berries began on October 19, 1936, and ended on January 30, 1937. As usual, the berries picked from different beds were weighed separately. The consolidated yields of the different beds are shown in the following table.

*Discussion of results.*—It may be well to describe the character of the different materials used for mulching, in order to make a just appraisal of the results. As it is well known, the pine needles are fine and gave a complete cover. The dried reeds used were also fine and likewise gave good cover. The straw mulch was a mixture of barley, oats, and wheat straw. In comparison with the first two mulching materials, the straw mulch did not give a complete cover. In the check plots, the earth mulch was brought about by the stirring of the soil in the application of the fertilizer and the subsequent weedings. In the mulched beds, the weeds were pulled. The berries harvested from the earth mulched beds had some soil particles adhering to them, which fact enhanced its yield in contrast with the straw mulch.

If we compare the pine needle mulch and the reed mulch, which identically gave complete cover, the reed mulch gave better results than the pine needle mulch, and the best in these tests. Pine needle mulch, however, was superior to either the earth or straw mulch.

*Summary.*—Pine needle mulch does not markedly affect the yield of berries. While the dried reed mulch was superior to pine needle mulch, its exclusive use in our cultures is very limited due to lack of sufficient supply.

In relation to the inimical effect of pine needle compost shown in the preceding tests, the fact learned from the mulching tests is that pine needles can be used as mulching material for strawberries without serious effects. After the crop, the partly decomposed pine needle mulch should be gathered and taken away or burned. The field with pine needle mulch should not be immediately utilized for another strawberry crop.

TABLE 5.—*Showing the consolidated yields in kilos of berries per bed, the total for the three replications of each variable, the average per bed, and the calculated yield per hectare*

| Pine needle mulch | | Reed mulch | | Straw mulch | | Check Earth mulch | |
|---|---|---|---|---|---|---|---|
| Plot No. | Yield in kilos | Plot No. | Yield in kilos | Plot No. | Yield in kilos | Plot No. | Yield in kilos |
| 1–A | 5.32 | 2–B | 7.45 | 3–C | 8.06 | 4–D | 9.60 |
| 5–A | 12.54 | 6–B | 16.09 | 7–C | 9.52 | 8–D | 9.43 |
| 9–A | 14.40 | 10–B | 14.72 | 11–C | 8.67 | 12–D | 10.67 |
| Total | 32.26 | | 38.26 | | 26.25 | | 29.70 |
| Average per bed | 10.75 ±0.168 | | 12.75 ±0.273 | | 8.75 ±0.472 | | 9.90 ±0.302 |
| Calculated yield per hectare | 2,388.9 | | 2,833.3 | | 1,944.4 | | 2,200.0 |

VII. FERTILIZER TESTS OF STRAWBERRY (SERIES 11.)

*Review of a Previous 3-Year Fertilizer Tests (Series 1.)*—Mr. José de Leon, former Superintendent of this station, started fertilizer tests of strawberry in the 1934–35 season. The present writer continued these tests and carried them for two seasons more, 1935–36 and 1936–37, closing them last season. The object of these tests was to prove the efficiency of compost as fertilizing material for strawberry in comparison with two well known standard commercial fertilizers. The fertilizers tested were compost at one petroleum canful for 1.2 sq. m., compost plus ammophos plus sulphate of potash (20 N—20 $P_2O_5$—8 $K_2O$), ammophos plus sulphate of potash, Nitrophoska No. 3 (16.5 N—16.5 $P_2O_5$—8 $K_2O$) and check. The commercial fertilizers were applied at the rate of 1 ton per hectare. The beds were replicated three times; as in every season the 40-meter long beds ran throughout the length of the field. The Wilson variety only was used for all these tests. In the second season, 1935–36, the yields of the beds were greatly depressed due to severe strawberry thrip infestation. The consolidated results may be seen in the following table.

TABLE 6.—*Showing the yearly average yield in kilos of berries per bed or plot of the different treatments, the three-year average, the calculated yield per hectare, the increase of berries over the check and the value thereof at ₱0.30 per kilo.*

| Year | Compost | Compost + ammophos + sulphate of potash | Ammophos + sulphate of potash | Nitro-phoska | Check |
|---|---|---|---|---|---|
| | *kilos* | *kilos* | *kilos* | *kilos* | *kilos* |
| First | 32.40 | 43.33 | 37.67 | 28.45 | 26.63 |
| Second | 10.59 | 15.91 | 15.85 | 13.05 | 11.14 |
| Third | 27.56 | 30.88 | 21.24 | 20.96 | 13.09 |
| 3-year average | 23.517 | 30.040 | 24.920 | 20.82 | 16.953 |
| Calculated yield per hectare | 3,674.5 | 4,693.8 | 3,893.8 | 3,253.1 | 2,648.9 |
| Increase over check | 1,025.6 | 2,044.9 | 1,244.9 | 604.2 | |
| Value of increase | ₱307.68 | ₱613.47 | ₱373.47 | ₱181.26 | |

In accordance with the above results, the plot treated with compost plus ammophos plus sulphate of potash was the best, followed by the same fertilizer alone, and the third was compost. Compost-treated beds yielded slightly lower by 219.3 kilos than the ammophos plus sulphate of potash beds. It was made clear by these tests that compost is essential for good strawberry yield under our soil conditions; that ammophos plus sulphate of potash did the best in combination with compost; that, while ammophos plus sulphate of potash did better than compost, the

difference was small; and that Nitrophoska, at a cost of ₱190 per ton including freight, was unprofitable for strawberry.

The above fertilizer tests, while useful in the research regarding compost as fertilizing material for strawberry, was not very satisfactory with respect to commercial fertilizers, because it was not comprehensive enough, relying on only two commercial fertilizers, which are costly. Both these fertilizers may be good when new, approximating closely their trade compositions, and when their constituents are the only ones required by the plants; but in this country where the climate is humid, these fertilizers often reach their destination moist or wet, with their compositions greatly disturbed. This may be one reason why at certain times, they do not give the expected results.

A new series of fertilizer tests was evidently desirable, retaining the ammophos plus sulphate of potash for comparison. Four of the fertilizers used were commercial, one of which was a complete fertilizer. Sulphate of potash to make 8 per cent was added to the other three fertilizers, containing only nitrogen and phosphorus, in order to make them complete also. The other two complete fertilizers were local mixtures, which are generally used for our vegetable work.

*Object.*—The object of these tests was to determine the most profitable fertilizer for strawberry.

*Materials and Methods.*—The field chosen for these tests was of fairly uniform conditions and one of the best fields of this station. It is of interest to give the chemical analyses, made in April, 1934, by Dr. M. M. Alicante of the Bureau of Science as follows:

TABLE 7.—*Showing the results of chemical analyses of the Baguio Plant Industry Experiment Station soil sample No. 6*

| | Analyses | Sample St. 6 |
|---|---|---|
| | Lime requirement | 5–10 tons lime |
| | pH value | 5.6 |
| Total by fusion method | Nitrogen (N) | 0.229 per cent |
| | Phosphoric anhydride $P_2O_5$ | 0.362 per cent |
| | Potash ($K_2O$) | 0.534 per cent |
| | Calcium oxide (CaO) | 0.626 per cent |
| | Manganese oxide (MnO) | 0.178 per cent |
| | Iron oxide ($Fe_2O_3$) | 11.99 per cent |
| | Aluminum oxide ($Al_2O_3$) | 16.34 per cent |
| | Total carbon | 4.300 per cent |
| | Carbonate carbon | 0.045 per cent |
| | Organic carbon | 4.305 per cent |
| | Loss on ignition | 15.04 |
| | Copper (Cu) | 0.076 per cent |
| | Boron (B) | None |
| | Magnesium oxide (MgO) | 1.72 per cent |

Dr. Alicante states regarding this sample:

"As regards to sample No. 6 the soil contains unusually high percentage of nitrogen but low in both phosphoric acid and potash in proportion to its nitrogen content. These results indicate the need of phosphoric acid application supplemented with nitrogen and potash.

"The soil of No. 6 should be treated with concentrated fertilizer containing nitrogen and phosphorus and with very small amount of potash."

The field was previously planted to cabbage, followed by beans, which were turned under just before using it for these tests. It was divided into 28 equal-sized beds of 25 sq. m. each. The layout of the beds, replicated four times, was as described as Arrangement 11. The variety Hood River supplied the plants for these tests.

The different treatments or variables were:

A. Ammophos plus sulphate of potash (20N—20$P_2O_5$—8 $K_2O$)
B. Leunaphos No. 2 plus sulphate of potash (16.5 N—20$P_2O_5$—8 $K_2O$)
C. Sta. Mixture No. 1 (10 N—15 $P_2O_5$—8 $K_2O$)
D. Sta. Mixture No. 2 (10 N—8 $P_2O_5$—6 $K_2O$)
E. Fertilica (10 N—10 $P_2O_5$—24 $K_2O$)
F. Pamco Leunaphos (16 N—20 $P_2O_5$—8 $K_2O$) plus sulphate of potash.
G. Check. (No fertilizer)

Planting for the 28 beds was made during August 20–23, 1936.

On September 14, 1936, one-half of the different fertilizer treatments, at the rate of one ton per hectare, was applied and the other half was applied on September 25. Thereafter the beds were uniformly mulched with pine needles mixed with grasses.

*Observations.*—Observations were made of the different fertilized beds in order to see the reactions of the plants. Ocular observation alone, however, failed to reveal the best among the different fertilizers. As a rule, all the fertilized beds showed dark green color of leaves and good development and height. The check beds showed poorer development and a noticeable yellowish color of leaves.

The first set of variables from A–1 to E–5 was attacked by white grubs, but the infestation was not serious.

*Results.*—Harvest was started simultaneously from all the beds on November 25, 1936, and was completed on April 26,

TABLE 8.—*Showing the yield in kilos of berries of the replicated beds, the total yield for each treatment and the average yield for each treatment.*

| Ammophos + sulphate of potash | | Leunaphos No. 2 + sulphate of potash | | Sta. mixture No. 1 | | Sta. mixture No. 2 | |
|---|---|---|---|---|---|---|---|
| Plot | Kilos | Plot | Kilos | Plot | Kilos | Plot | Kilos |
| A-1 | 8.72 | B-2 | 7.82 | C-3 | 6.46 | D-4 | 10.62 |
| A-8 | 15.74 | B-9 | 17.16 | C-10 | 18.37 | D-11 | 21.80 |
| A-19 | 15.35 | B-20 | 15.69 | C-21 | 15.26 | D-15 | 10.10 |
| A-26 | 15.52 | B-27 | 15.72 | C-28 | 13.88 | D-22 | 13.06 |
| Total | 55.33 | | 56.39 | | 53.97 | | 55.58 |
| Average per bed | 13.843 ±0.293 | | 14.098 ±0.539 | | 13.493 ±0.539 | | 13.895 ±1.26 |

| Fertilica | | Pameo Leunaphos + sulphate of potash | | Check | |
|---|---|---|---|---|---|
| Plot | Kilos | Plot | Kilos | Plot | Kilos |
| E-5 | 11.50 | F-6 | 12.42 | G-7 | 11.52 |
| E-12 | 17.16 | F-13 | 17.29 | G-14 | 8.92 |
| E-16 | 13.95 | F-17 | 12.96 | G-18 | 14.26 |
| E-23 | 16.51 | F-24 | 17.82 | G-25 | 15.04 |
| Total | 59.12 | | 60.49 | | 49.74 |
| Average per bed | 14.780 ±0.438 | | 15.123 ±0.573 | | 12.435 ±0.438 |

1937, a period of five months. The yields of the different plots may be shown in the following table.

TABLE 9.—*Showing the fertilizer treatments, calculated yield per hectare, increase of berry yield over check and value thereof, cost of fertilizer, and gain or loss by the use of the fertilizer over check.*

| Variable or treatment | Calculated yield per Hectare | Increase of berries over check | Increase: Value thereof [1] | Total cost of fertilizer per ton [2] | Gain or loss over check |
|---|---|---|---|---|---|
| | *kilos* | *kilos* | *Pesos* | *Pesos* | *Pesos* |
| A. Ammophos plus sulphate of potash | 5,537.2 | 563.2 | 168.96 | 181.53 | —12.57 |
| B. Leunaphos No. 2 plus sulphate of potash | 5,639.2 | 665.2 | 259.56 | 137.72 | 121.84 |
| C. Station Mixture No. 1 | 5,397.2 | 423.2 | 126.96 | 105.33 | 21.63 |
| D. Station Mixture No. 2 | 5,558.0 | 584.0 | 179.20 | 101.18 | 74.02 |
| E. Fertilica | 5,912.0 | 938.0 | 281.40 | 145.00 | 136.40 |
| F. Pamco Leunaphos plus sulphate of potash | 6,049.2 | 1,075.2 | 322.56 | 137.72 | 184.84 |
| G. Check | 4,974.0 | | | | |

[1] At ₱0.30 per kilo. [2] Total cost of fertilizers includes transportation and the expenses in local compounding.

*Interpretation of results.*—From these first season results, as graphically shown in the preceding table, it is patent that all the fertilizers gave good account of themselves in the greater production of berries over the check.

In the calculated yield per hectare and in the increase of berries over the check, the fertilizers gave yields in the following order:

1. F—Pamco Leunaphos plus sulphate of potash.
2. E—Fertilica.
3. B—Leunaphos No. 2 plus sulphate of potash.
4. D—Station Mixture No. 2.
5. A—Ammophos plus sulphate of potash.
6. C—Station Mixture No. 1.

The berries were valued at ₱0.30 per kilo, being the average price that can be obtained for all the first-class berries and culls picked during the whole season from any strawberry field.

The most important result, however, to be derived from any fertilizer test, overshadowing all other facts, is the net profit gained by the use of each specific fertilizer. The fertilizers used varied markedly in price from ₱101.18 to ₱181.53 per ton. Naturally the total outlay for each fertilizer used including transportation and the labor in mixing same has to be deducted from the corresponding increased value of yield. When

this is done the order of increase in yield does not coincide exactly with the order of net profit. The order of profit of the different fertilizers used was as follows:

| | |
|---|---|
| 1. F—Pamco Leunaphos plus sulphate of potash | ₱184.84 |
| 2. E—Fertilica | 136.40 |
| 3. B—Leunaphos No. 2 plus sulphate of potash | 121.84 |
| 4. D—Station Mixture No. 2 | 74.02 |
| 5. C—Station Mixture No. 1 | 21.63 |

On account of its exorbitant cost, ammophos plus sulphate of potash registered a loss of ₱12.57, although it ranked fifth in the increase of berries over the check. This fertilizer, however, maintained its performance as obtained in the three-year results, and even registered higher yield by reason of the better soil used and the smaller plots used in these one-year tests.

The results of our second series of fertilizer tests, using cheaper forms of fertilizers and giving decidedly better and more profitable results than our old standby—the ammophos plus sulphate of potash in combination with compost—change entirely the aspect of our experimental and commercial work with strawberry in relation to the fertilizer to be preferred. This is the outstanding gain for the station derived from the second series of fertilizer tests.

*Summary.*—Summarizing tentatively our results we may state—

1. Pamco Leunaphos plus sulphate of potash (16 N–20 $P_2O_5$–8 $K_2O$), Fertilica (10 N–10 $P_2O_5$–24 $K_2O$), and Leunaphos No. 2 plus sulphate of potash (16.5 N–20 $P_2O_5$–8 $K_2O$) in the order named are the best and most profitable fertilizers for strawberry under our soil conditions.

2. The results of these tests in having the Leunaphos plus sulphate of potash with the 16 per cent nitrogen, 20 per cent phosphoric acid, and 8 per cent potash, are in line with the recommendation borne by the chemical analyses of the soil.

3. Based upon the constituents of Leunaphos plus sulphate of potash for our soil conditions, the proportion of the NPK constituents in the best fertilizer found may be expressed by the ratio 4:5:2.

4. Ammophos plus sulphate of potash (20 N–20 $P_2O_5$–8 $K_2O$), while it gave marked increase over the check, yet by reason of the high price per ton, turned out unprofitable in comparison with the other fertilizers used in these tests.

## GENERAL SUMMARY

In the light of findings observed from a careful checking of the results of the foregoing tests, what can be recommended to strawberry growers, whose fields have similar soil and climatic conditions as those obtaining in the Baguio Plant Industry Experiment Station?

The strawberry varieties found adapted and which can be recommended with confidence to growers are Hood River and Wilson. Missionary may come next to these varieties, though its berries are sour. Of the newly introduced varieties, Narcissa especially, Clermont, and Aroma are promising. They are in process of being rapidly multiplied.

Rooted plants grown in the nursery are better and yield more than the unrooted plants freshly taken from the old clumps. These rooted plants may easily double the berry yield of the other material.

Strawberry seedlings are also good planting materials, especially if from pure strains. In spite of the unselected plantings, seedlings outyielded asexually propagated materials, such as the runners and the plants.

Seedling selection is a good method for improving strawberries for certain characters and qualities and for breeding better adapted strains from recalcitrant varieties. Several seedling strains of the varieties Wilson, Missionary, Mastodon, Bellmar, Big Joe, and Fairfax were isolated for further testing and propagation.

The partly decomposed pine needle mulch, when incorporated into the soil, was found inimical to berry production.

Pine needle mulch, however, does not significantly affect strawberry yield. After the harvest the pine needle mulch should be either gathered and thrown away or burned. The field planted to strawberry with the pine needle mulch should *not* be immediately followed by another strawberry crop.

While our previous finding with limited number of fertilizers for three years, ammophos plus sulphate of potash especially in combination with compost was the best, our recent tests comparing this fertilizer with five others showed that it was unprofitable by reason of high cost.

Pamco Leunaphos plus sulphate of potash, Fertilica, and Leunaphos No. 2 plus sulphate of potash did very much better than the ammophos plus sulphate of potash and gave the most profit in the order named. The station mixtures Nos. 2 and 1, especial-

ly No. 2 were even better in the matter of profit than the ammophos plus sulphate of potash.

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# DISEASE-RESISTANT RICE HYBRIDS PRODUCE SUPERIOR YIELDS IN COMMERCIAL TRIALS

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THREE PLATES

Since the announcement of the isolation of hybrid strains of rice resistant to the rice stem rot (*Sclerotium oryzæ* Catt.) four years ago, interest in the propagation of rice hybrids proceeded with little interruption; and in 1935 sufficient seed was available to test them in Maligaya Rice Station on a small scale under field conditions. Outstanding of the rice hybrids that have been tried are Ramay[1] x Inadhica, Ramay x Elon-elon, Elon-elon x Inadhica and Ramay x Khao Bai Sri. Several derivatives of these crosses have been selected adequately through an ardous process of elimination, and although the establishment of disease-resistance has been the prime basis of selection, as it is considered the chief bulwark of defense against destructive diseases of this type, needless to say, other characters were also given due attention so as to meet squarely the demands of the planters, merchants and consumers. In every planting, the parent varieties were grown alongside for comparative purposes.

## RESPONSE OF COMMERCIAL VARIETIES TO STEM ROT

Of the twenty commercial rice varieties that have been previously subjected to artificial inoculations, or to natural conditions of exposure in heavily infested soils,[2] all showed suscep-

[1] This variety, introduced into the Philippines in 1919 by Ex-Director Fidel A. Reyes of the former Bureau of Commerce and Industry, is popularly but erroneously known locally as "Ramai." For consistency and to give due credit to its country of origin, French Indo-China, its correct Malayan name should be retained and written thus, "Rá-mây," as shown in an article by M. J. Robin, entitled "Les différentes variétés de riz cultivées à la Station de Cantho" in Bulletin Agricole de l'Institut scientifique de Saigon, 2[e] Année, N° 2, 40–45, Fevrier 1920. The "Ramay" form of writing is obviously closer to its original nomenclature and should be acceptable and made official for facility in writing and for uniformity of usage.

[2] Reyes, G. M. A preliminary report on the stem-rot of rice. Philippine Agricultural Review 22 (1929) 313–31, Pl. LIV–LXIII.

tibility in varying proportions to stem rot (Plate 1). None of the more popular native varieties exhibited complete freedom from the disease, although Macan Biñan showed fairly good resistance, while the exotic varieties, Ramay and Elon-elon, were moderately resistant, showing commendable superiority over the age-worn local sorts. These resistant varieties, however, have disadvantages which make them unpopular for general planting; showing that none of our existing varieties is wholly satisfactory in all respects. Efforts are directed therefore towards producing new varieties that combine disease resistance with hardiness, productivity and good eating quality and present development seems well on the road towards this end. This mode of approach offers great possibilities of relief to our local rice growers, a task which finds its natural opportunity for expression with amateur plant breeders and plant pathologists.

## FIELD OBSERVATIONS, 1934–1935

In September, 1934, a trip was made to Maligaya Rice Station,[3] Nueva Ecija, and a thorough-going inspection of the rice fields revealed the following facts:

1. The stem rot of rice was accentuated in Maligaya Rice Station by the prevalence of warm, humid weather and other contingent environmental factors.

2. In the trial plantings of the new rice hybrids grown side by side under natural conditions, Raminad Str. 3 [4] showed considerable resistance to the attack of *S. oryzæ* (Plate 2), while strains 1 and 2 of the same cross showed some unmistakable signs of attack, indicating fairly well their reaction to the disease.

3. Ramay and Elon-elon were very little affected by the stem rot disease, while Khao Bai Sri, Dinalaga and Inadhica showed susceptibility in their descending order. This varietal response to the disease (excepting the variety Dinalaga) confirmed the writer's previous findings in Alabang Stock Farm, Rizal Province and in Santa Ana, Pampanga.[5]

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[3] Reyes, G. M. Report on a survey of rice diseases in Maligaya Rice Station in 1934. Unpublished.

[4] Reyes, G. M. Rice hybrids versus stem rot disease. Philip. Journ. Agric. 7 (1936) 413–417. Pls. 1–3.

[5] Reyes, G. M. Op. cit.

Reports from other rice-producing regions revealed that in 1934 the stem rot of rice was also rampant; serious outbreaks of which have been corroborated from specimens received for diagnoses. Weather conditions exceedingly favorable for the progress of the disease at that time afforded an unusually severe test for varietal resistance. In 1935, Dr. Juan P. Torres, plant breeder of the Bureau of Plant Industry, in a verbal communication to the writer confirmed the previous observation that Raminad strain 3 was the most resistant of all the hybrid rices that have been multiplied in Maligaya Rice Station, in spite of the heavy infestation noted the preceding year.

While the hybrid rice, Raminad strain 3, has not been planted sufficiently long in many rice regions, except in Nueva Ecija, to warrant a fully reliable conclusion, yet the three years plat test conducted in Maligaya Rice Station have demonstrated the worth of this resistant segregate and the results have been quite promising under natural conditions, that it seems as though the planting of this hybrid strain will rapidly increase judging from the many requests for seed of this resistant hybrid strain. Everything being equal there seems little doubt that it will do equally well in other rice regions.

The superiority of Raminad strain 3 (Plate 2) with reference to productive capacity over its sister strains may be gleaned from Table 1.

TABLE 1.—*Comparative yield of strains of a hybrid (Ramay ♀ x Inadhica ♂ $F_8$) and of the parent varieties under field conditions* [a]

| Variety or strain | Mean yield per hectare | Difference (+ or —) [b] | |
|---|---|---|---|
| | | Over Ramay | Over Inadhica |
| | *Cavans* | *Cavans* | *Cavans* |
| Ramay | 67.0±2.10 | | |
| Raminad Str. 1 | 61.9±0.87 | −5.1±1.72 | + 5.8±1.31 |
| Raminad Str. 2 | 68.9±0.81 | +1.9±1.70 | +12.8±1.29 |
| Raminad Str. 3 | 74.3±1.07 | +7.3±1.78 | +18.2±1.39 |
| Inadhica | 56.1±0.87 | | |

[a] From 1935 plat trials (5 replications, plants planted singly) conducted in Maligaya Rice Station, Bureau of Plant Industry. Figures supplied by the agronomy section.

[b] Plus or minus sign means increase or decrease.

From Table 1 it is thus apparent that Raminad strain 3 leads all the strain selections from the cross, Ramay ♀ x Inadhica ♂, in yielding capacity, exceeding also the female parent variety

by 7.3 cavans and outyielding by a respectable margin the male parent by 18.2 cavans.

It appears evident that the tolerance of Ramay to *Sclerotium oryzæ* has been carried over to at least one of its hybrid progenies manifesting in a marked degree in Raminad strain 3;[6] it having been demonstrated previously that Ramay is possessed of some natural inherent resistance to the rice stem rot while Inadhica is rather susceptible to it. Aside from the possession of desirable agronomic and market qualities, this hybrid strain is valuable because of its relatively higher degree of resistance to the rice stem rot and to the brown linear spot (*Cercospora oryzæ* Miy.).

## COMMERCIAL TRIALS, 1935–1936

In commercial plantings conducted in Maligaya Rice Station during the regular rice seasons, 1935–1936 and 1936–1937, the available data furnished by this station [7] as to the comparative yield of rice hybrids and their parent varieties are shown in Table 2.

TABLE 2.—*Comparative yield of rice varieties and hybrids ($F_9$ and $F_{10}$) in commercial trials in Maligaya Rice Station*

| Hybrid or parent variety | 1935–1936 season | | 1936–1937 season | | Average yield |
|---|---|---|---|---|---|
| | Days to maturity | Yield per hectare | Days to maturity | Yield per hectare | |
| | | *Cavans* | | *Cavans* | *Cavans* |
| Ramay | -------- | Ave.–53.10 | -------- | Ave.–54.42 | 53.76 |
| Ramay × Elon-elon Str. 1 | 187 | 74.31 | 189 | 85.34 | 79.82 |
| Ramay × Elon-elon Str. 2 | 192 | 76.79 | 189 | 66.17 | 71.48 |
| Ramay × Elon-elon Str. 3 | 181 | 55.22 | 187 | 67.09 | 61.15 |
| Ramay × Elon-elon Str. 4 | 186 | 58.67 | 186 | 32.46 | 45.56 |
| Elon-elon | -------- | Ave.–54.70 | -------- | Ave.–59.41 | 58.40 |
| Elon-elon × Inadhica Str. 1 | 183 | 46.60 | 178 | 54.11 | 50.35 |
| Elon-elon × Inadhica Str. 2 | 186 | 56.30 | 185 | 64.09 | 60.19 |
| Elon-elon × Inadhica Str. 3 | 179 | 45.73 | 176 | 61.52 | 53.62 |
| Elon-elon × Inadhica Str. 4 | 196 | 49.83 | 190 | 70.18 | 60.00 |
| Elon-elon × Inadhica Str. 5 | 183 | 50.69 | 181 | 68.02 | 59.35 |
| Inadhica | -------- | Ave.–52.00 | -------- | -------- | 52.00 |
| Ramay × Khao Bai Sri Str. 1 | 191 | 49.83 | 185 | 77.90 | 63.86 |
| Ramay × Khao Bai Sri Str. 2 | 194 | 51.99 | 189 | 77.29 | 64.64 |
| Ramay × Khao Bai Sri Str. 3 | 183 | 54.79 | 191 | 72.34 | 63.56 |
| Khao Bai Sri | -------- | Ave.–31.88 | -------- | Ave.–59.95 | 45.66 |
| Khao Bai Sri × Guinangang Str. 1 | 138 | 44.42 | 146 | 43.88 | 44.15 |
| Ramay × Inadhica Str. 1 | 190 | 50.26 | 188 | 61.69 | 55.97 |
| Ramay × Inadhica Str. 3 | 192 | 91.33 | 198 | 91.31 | 91.32 |
| Ramay × Inadhica Str. 4 | 190 | 73.91 | 193 | 71.19 | 72.55 |
| Ramay × Inadhica Str. 5 | 199 | 58.25 | 190 | 80.59 | 69.42 |

[6] Reyes, G. M. Op. cit.

[7] Through the courtesy of Mr. Ramon V. Manio, acting superintendent.

A careful examination of the preceding table will reveal the unmistakable fact that there was almost a general increment in the yield of the varieties and hybrids in the second year planting. For comparative purposes, their periods of maturity are also given to serve as guide to planters. Of the hybrids that gave fairly high yields in both seasons were Ramay x Elon-elon strains 1 and 2, and Ramay x Inadhica strains 3 and 4. They also show promise of being commercially important for possessing desirable market or agronomic qualities. It is highly interesting to note that the hybrid selection, Raminad strain 3 outyielded all the varieties and hybrids that have been propagated by the Maligaya Rice Station as can be readily seen in Table 2. It is considered one of the most prolific hybrid varieties and its performance during the two seasons in small commercial scales showed clearly its superiority over the other hybrids, hence the release of the seeds this year. As to Raminad strain 4 (Plate 3), although possessed of especially desirable characteristics and a fairly good yielder, it cannot be recommended for general planting owing to the facility with which it succumbs to stem-rot infection, while Raminad strain 1 was found quite unsatisfactory in more respects than one (Plate 3).

Small quantities of seed of this new hybrid strain, Raminad strain 3, were given away free by the Maligaya Rice Station to farmers for coöperative trial plantings with the object of ascertaining its performance when subjected to differences of existing growing conditions. As we know varieties do not produce the same in all localities with varying conditions, and changes of environment may affect also the resistance or susceptibility of a variety. The results of these tests, according to the 1936 Annual Report of the Director of Plant Industry were very encouraging. This hybrid strain together with Ramelon are now being propagated more extensively in the different rice stations of the Bureau of Plant Industry for the purpose of raising seeds for general distribution. This prompted the release of this brief note. By the way, the seeds are not given free of charge; but even at the rather exorbitant Government price of ₱3.50 a cavan, the demands for seed could not be met as yet. All available seed has been bought up early by eager growers who are always interested in experimental work and always on the alert to try new and improved varieties reputed to combine yielding ability, quality and resistance to disease. It would be interesting what these seed buyers would report after their first planting, and it would be more interesting,

indeed, if this new hybrid strain could be grown in various regions in areas where natural epidemics of the disease are known to have occurred in the preceding season. Such natural exposures would find more suitable expression of its real worthiness under existing soil and climatic conditions as well as to other deterrent factors. This is also of vast importance for the reason that it would find greater opportunities of contact with other possible new biologic forms of the causal organism. If one is looking for something new in rice, this hybrid strain is recommended, especially so from the production standpoint as well as for other desirable qualities. Seed growers should be particularly interested in it at this stage of the game, but the economic importance of this hybrid strain depends upon how careful the seeds are handled in all operations [8] and kept free from admixture of other varieties. The rice growers depend on the reliability of the seeds they buy which should be certified and taken to mean as 100 per cent pure, and free from destructive diseases or pests, or from weed seeds. The best time to select for seed for general propagation is just before the crop is harvested, after the heads are fully matured.

## SUMMARY

1. A new variety of rice has been developed which is attracting considerable interest among rice growers. Raminad strain 3 is the name given to the new promising variety, showing a decided improvement over the parent varieties. It is bound to become popular because of the possession of certain desirable fine qualities, being a good yielder, besides offering complimentary resistance to the rice stem rot.

2. Outstanding of the resistant hybrid strains, it was noticeable in two demonstrations under field conditions that Raminad strain 3 was easily the heaviest yielder.

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[8] Meticulous care should be taken as regards sowing and planting, harvesting and threshing, drying and storing, where mixtures of varieties or seeds are likely to happen.

# ILLUSTRATIONS

PLATE 1

A plat of a susceptible variety, Macan I, showing severe infection by the stem rot disease caused by *Sclerotium oryzæ* Catt. Only a few panicles can be discerned in the rear plants in a total of one hundred plants, and complete sterility or stunting of plants in the foreground. (Photographed by G. M. Reyes.)

PLATE 2

Individual rice plants cut at ground level, representing graphically the response of hybrid strains and their parent varieties to *Sclerotium oryzæ* Catt. (Photographed by G. Panlilio of the Bureau of Science, Manila.)

PLATE 3

Plants of two susceptible rice hybrid segregates showing in a measure the degrees of infection caused by *Sclerotium oryzæ*. Note and compare the plants carefully. (Photographed by G. Panlilio of the Bureau of Science, Manila.)


PLATE 1.

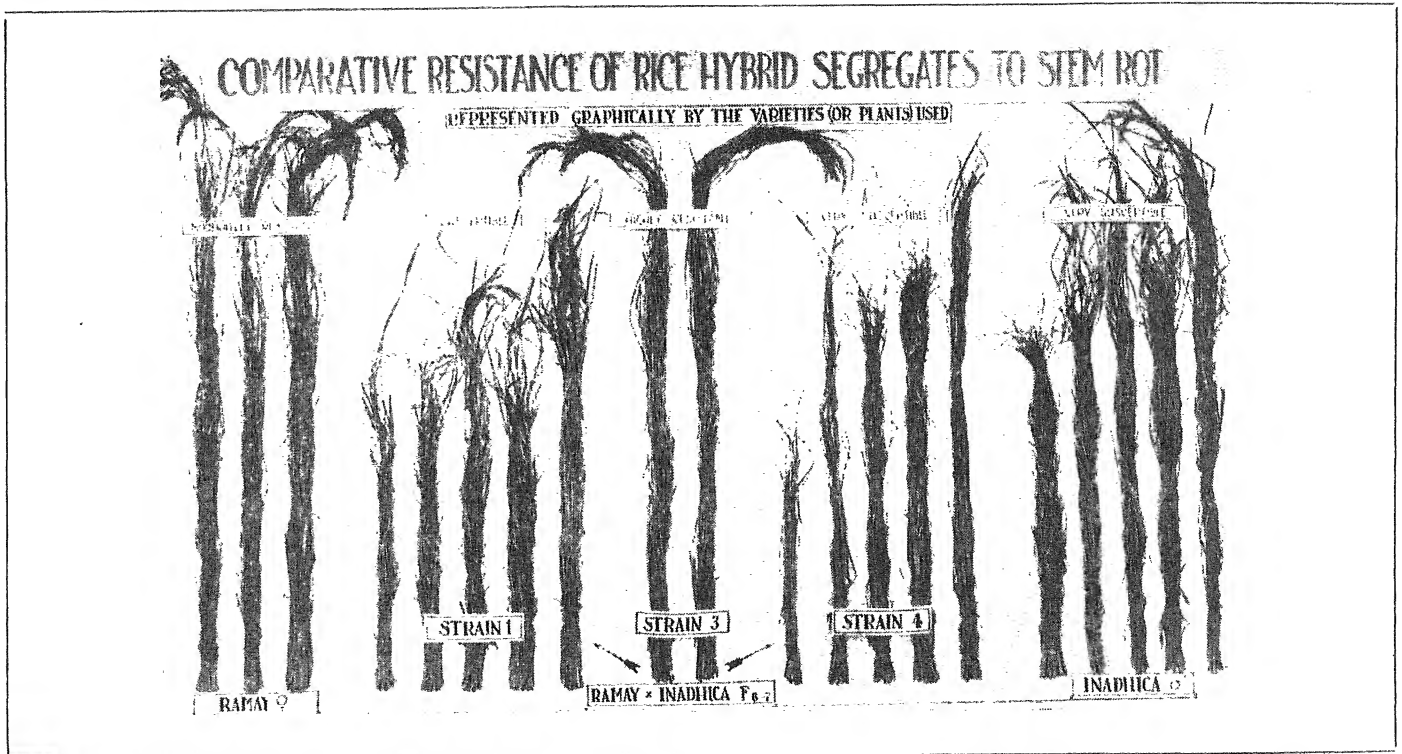
COMPARATIVE RESISTANCE OF RICE HYBRID SEGREGATES TO STEM ROT
REPRESENTED GRAPHICALLY BY THE VARIETIES (OR PLANTS) USED
STRAIN 1
STRAIN 3
STRAIN 4
RAMAY ♀
RAMAY × INADHICA $F_{6-7}$
INADHICA ♂

PLATE 2.

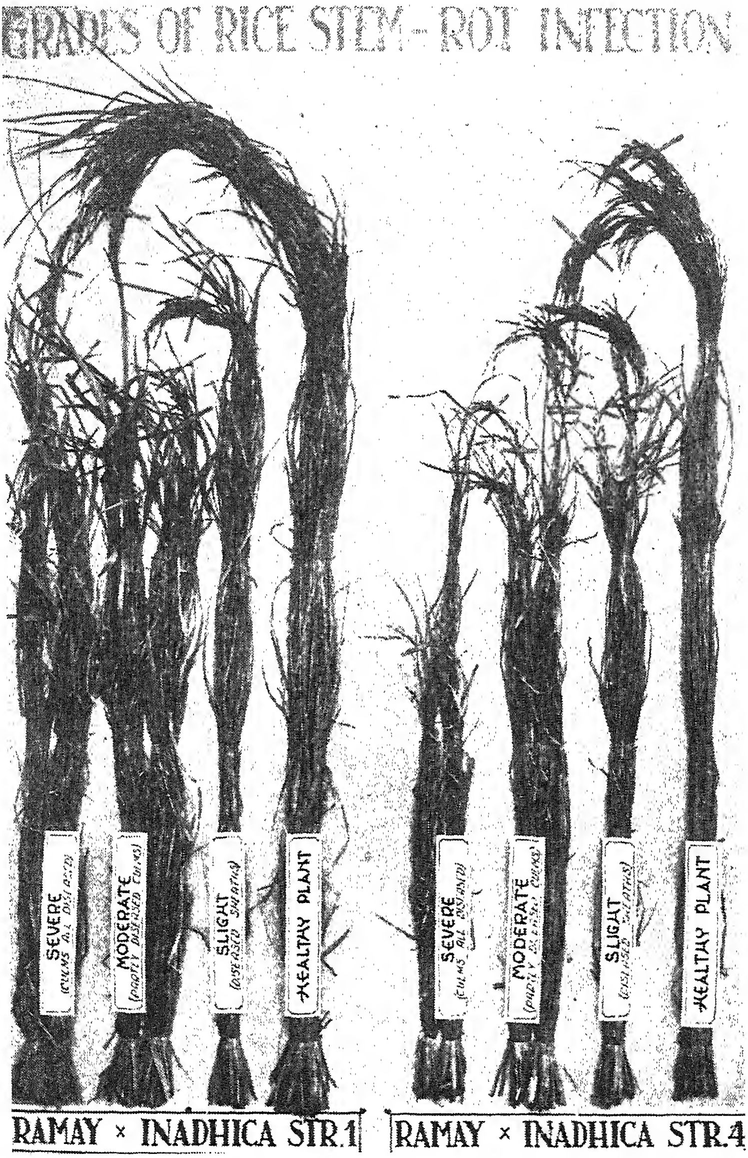
GRADES OF RICE STEM-ROT INFECTION
SEVERE
(CULMS ALL DISEASED)
MODERATE
(PARTLY DISEASED CULMS)
SLIGHT
(DISEASED SHEATHS)
HEALTHY PLANT
RAMAY × INADHICA STR.1
SEVERE
MODERATE
SLIGHT
HEALTHY PLANT
RAMAY × INADHICA STR.4

PLATE 3.

# FARMERS' CIRCULAR SECTION

# CIGAR WRAPPER LEAF TOBACCO CULTURE

Farmers' Circular 15

By Domingo B. Paguirigan
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and

Primitivo P. Tugade
*Assistant Agronomist*

THREE PLATES

*Choice of varieties.*—For shade culture, the native varieties *Vizcaya* and *Marogui* and for open cultures *Baker Sumatra* and *Ilagan Sumatra* are recommended. In the Ilocos Provinces the *Sumatra* varieties are also made to produce extra fine wrapper by shading them.

*Soil requirements.*—Wrapper tobacco has been successfully grown in well drained soils ranging from silty loam to sandy loam of at least more than normal fertility. Virgin soils are of course the best. The small valleys that abound in the Ilocos Provinces because of yearly deposits of rich sediment from the surrounding hills and mountains are also ideal for wrapper tobacco.

*Climatic requirements.*—In regions of well defined dry and wet seasons like the Ilocos Provinces shade culture are the rule, whereas in those with short dry periods like the Cagayan Valley or with an even distribution of rainfall like Cotabato Valley, open cultures are quite practicable. In the interior valleys of the Ilocos Provinces, however, because of the reduced daylight, open cultures are also practicable. And in the lower and middle reaches of the Cagayan Valley because of delayed planting on account of the yearly floods up to the last week of November, shade cultures have to be resorted to.

The optimum seasonal periods of field operations for wrapper tobacco in the Ilocos Provinces and Pangasinan are as follows:

1. Sowing of seeds ........ October 1st to 15th.
2. Transplanting ............ November 25th to December 15th.
3. First harvest .............. January 20th to 30th.
4. Curing period............... From 25 to 30 days.

5. No. of priming (harvest) ........................ From 8 to 12 days.
6. Intervals of harvests.. From 5 to 7 days.

The above data apply to the native varieties. For the *Sumatra varieties* the intervals between the field operations are slightly reduced.

The optimum seasonal periods of field operations for wrapper tobacco in the lower and middle reaches of Cagayan valley are as follows:

1. Sowings of seeds ........ October 10th to 15th.
2. Transplanting ............. December 1st to 20th.
3. First harvest ............... February 1st to 15th.
4. Curing period ............. From 27 to 32 days.
5. No. of priming (harvests) ........................ From 8 to 12 days.
6. Intervals of harvests.. From 5 to 7 days.

In the upper reaches the sowing of seeds can be started as early as the middle part of September, the seedlings being ready for transplanting within about 45 days if the *Sumatra* varieties are grown. It does not usually pay to plant *Sumatra* varieties in the Cagayan Valley late in the year.

*Location and preparation of seed beds.*—A well drained, loamy and rich portions of the field near a good water supply should be selected for the seedbeds.

In August and the early part of September, the land is to be plowed and harrowed until the soil becomes pulverized and the plot divided into beds 1.2 meters wide and 10 meters long. The beds should be separated from each other by paths from 30 cm. to 1 meter wide. The soil dug from the paths to a depth of about 10 cm are transferred over the beds, thus raising them. The low paths will serve as drainage canals. Each seedbed must be provided with a portable nipa or cogon shed to protect the seedlings from the rain and intense heat of the sun. The front side of the shed should be raised about a meter high and the other side about 75 cm from the ground. The sheds should face the east in order that the seedlings receive the mellow heat of the morning sun but not the strong afternoon sun.

The final preparation of the seed beds consists in working the soil with hand tools until the soil particles become well pulverized.

*Sowing of seed.*—Before sowing the seed, it is always advisable to test the percentage of germination. The simplest method is to place 100 seeds between two pieces of blotting paper on a clay plate with a cover to fit, and then keep the blotting papers moist for one week. Then the percentage of germination can be determined by counting the number seeds which have germinated. Five or six grams of seed with a percentage of germination ranging from 70 to 100 per cent will be a sufficient quantity to sow in one bed that measures 1.2 by 10 meters. Before the seed is sown, the beds should be sterilized by pouring boiling water over them. The uniform distribution of seed in the bed is insured by mixing it with about 10 parts of wood ash or fine sand before sowing.

Each seed bed of the size mentioned above will produce not less than 1,000 seedlings, so that about 20 beds will be required for every hectare of native varieties, and 30 beds of the *Sumatra* varieties. It is always practical to sow a set of extra beds after two weeks as a precaution against adverse conditions.

When there are many red ants in the seed bed there is always danger of their carrying away the seeds. To prevent this it is a good plan to scatter corn meal made into a mash with sugar along the borders of every seed bed. The bait will attract the ants from the seeds.

*Care of seedlings.*—The soil in the seed beds should be kept moist all the time. Weeds of any kind should be pulled up as fast as they appear. If the seedlings are attacked by damping off disease all the infected ones, including the few healthy ones around the infected areas, should be removed together with the soil. Treating the infected area with 5 per cent formaline solution will minimize further infection.

Crowded areas in the seed bed are to be thinned so that the remaining seedlings will be about 4 cms. apart.

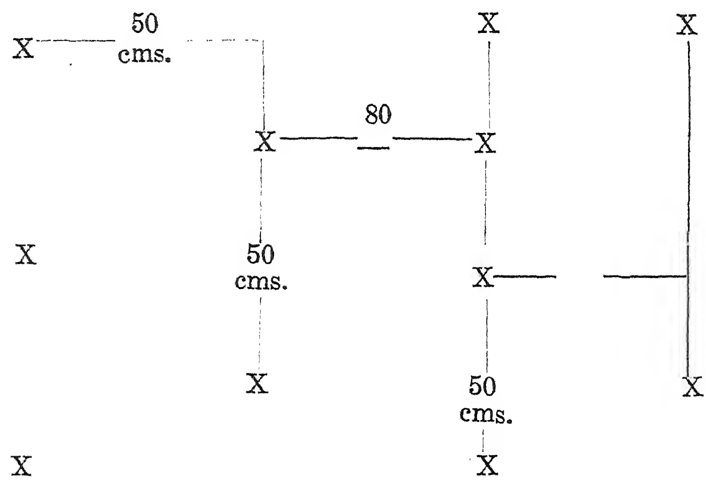
About two weeks before transplanting, the sheds of the beds are to be removed to expose the seedlings to the sun to make them strong.

*Preparation of the field.*—The land must first be thoroughly cleaned of weeds and stumps and then plowed and harrowed at least twice or until it becomes well pulverized. One or 2 days before planting furrows should be made in the field 80 cm. apart in the case of native varieties and shade cultures. The native plow is appropriate for this purpose.

It is not advisable to prepare furrows in open cultures of the Sumatra varieties but instead the rows should be marked off with pegs and strings, since there are two alternate distances between the rows.

*Planting.*—The seedlings are ready for transplanting in 45–60 days. Before pulling the seedlings for transplanting the beds should be watered to virtual saturation to make the soil soft, thereby preventing unnecessary breakage of the root systems of the plants. Only healthy and vigorous seedlings are to be selected for planting. Holes of sufficient depth equal to the length of the root system should be made with a trowel along the furrows, 70 cm. apart for the native varieties and in shade cultures.

In open cultures of the *Sumatra* varieties, the rows are indicated with strings marked every 45 or 50 cms. to show where the holes are to be made for setting out the seedlings. The rows should be alternately 80 and 50 cm. apart and the plants so set out that the quincunx arrangement is obtained (see accompanying diagram). This method of planting is based upon practices in Sumatra.




Showing Sumatra method of planting wrapper tobacco

*Cultivation.*—As soon as the plants become well established in the soil the field is ready for the first cultivation. In the shade culture the native plow is the appropriate implement, the operation consisting only of plowing twice between the rows. The cultivation in the open cultures really consists of banking,

which is completed in two operations. Banking is done by hoeing the middle of the widest distances between rows and placing the hoed up soil on the shorter spaces so that these are finally converted into beds. The depths of the resulting ditches depend on the rainfall, as these are intended incidentally for drainage. The maximum depth, however, should be 50 cm. Banking is also a Sumatra method. The operations should be completed within 20 days after transplanting.

*Control of pests and diseases.*—Of all the insect enemies of the tobacco plant, the cut-worms are the most destructive. Control is effected by dusting the plants with calcium arsenate. It is prepared by mixing one part commercial calcium powder with 16 parts of sterilized road dust. A bamboo tube with a node at one end and the other end covered with cheesecloth or fine meshed wire will make a cheap and practical duster. The dust is applied to each individual plant by shaking the tube to make the powder pass through the cheesecloth or wire until the leaves are sufficiently covered with a thin layer of the mixture. Occasional hand picking insures the perfect control of the worms.

Occasionally, plant lice also become very serious pests besides being responsible for the spread of the mosaic disease. Spraying with a solution of Blackleaf No. 40, a nicotine preparation, will control these insects. The solution is prepared by diluting every 150 cc. of the chemical with 5 gallons or the equivalent of one petroleum canful of water.

The safest guide to follow in controlling the fungus diseases of tobacco is to practice sanitation even to the extent of pulling up all the plants showing a diseased condition, especially those attacked by mosaic and wilt diseases. It is better to destroy a few plants rather than let the disease spread in the field.

*Topping.*—Topping should not be done as a rule unless the plants are extremely under-developed as this will tend to produce leaves that are too coarse. It is the desire to produce leaves with a fine body so that if topping is practiced at all only the flower buds are to be pinched off as they appear.

*Seed selection.*—The seed for subsequent planting should be taken only from healthy and vigorous plants. The plantation should be gone over thoroughly when the crop is about to flower and the finest and soundest plants selected. To keep the seeds pure the entire flower head of each individual plant should be covered with a 10–12 pound Manila paper bags before the

flowers open and until the seed pods are fully developed. When the capsules are matured they are cut off from the stem of the mother plant and hung inside the shed for thorough drying. The capsules are matured then to be hulled, and the seed stored in air tight containers. The seeds, if stored properly, will remain viable for at least two years.

*The shade tent.*—The frame work of the shade tent should be erected as early as practicable, so that by the time the plants are about half a meter high, the shading material (coconut leaves, talahib, cogon, banana leaves, etc.) can be placed over the frame without delay and as rapidly as possible. This is very important to obtain uniform texture of leaves. The posts of the shade tents should not be less than two and a half meters high from the surface of the ground. They should be set deep enough to enable them to resist windy spells. The posts should be erected in every four to five rows of tobacco crosswise and six to eight rows lengthwise. Once the tent is complete, cultivation is automatically stopped. In the case of native varieties, the shade should be dense enough to reduce sunlight inside by 40 per cent, while for the Sumatra varieties the sunlight should be reduced to 60 per cent only. In both cases, the shading materials should be evenly placed to insure a uniform penetration of sunlight.

*Harvesting.*—As the greatest uniformity of product is desirable, the leaves should be picked or primed from one to three at a time, as they show the slightest change in hue to lighter green, which shows the importance of bearing in mind the characteristic greenness of the immature leaves from the start.

The leaves are best harvested when they are in the most turgid condition, that is, during the early hours of the morning. And as many should be brought into the curing shed as can be strung or poled the same day.

*Stringing and poling.*—As soon as the leaves are gathered from the field they should be taken immediately into the shed where all broken and worm-eaten leaves are sorted out.

Stringing is done by passing a needle threaded with twine or string through the petiole of the leaves. About 100 leaves are arranged, preferably face-to-face and back-to-back and about one centimeter apart, on the string. Each end of the string is attached to a pole of practically the same length as the string, and about 2 to 4 cms. in diameter. If bigger curing

barns are available, longer poles and strings can be used. This method of poling originated in Cuba.

Native sticks can also be used provided the leaves are to be stuck just as described.

In the curing shed the poles are hung lengthwise of the building in such a way that the leaves of different poles do not touch each other and each section of the shed is filled from the highest to the lowest racks.

*The curing shed and the curing period.*—The curing shed should be spacious, provided with plenty of windows at the ends and at least one-half the sides made up of equidistant swinging doors, while the posts need to be substantial and durable. The roof and walls should be of an insulating nature and for reasons of economy, can be either cogon or nipa. The building may be of any size not less than 14 meters in width nor less than 3 meters high to the eaves, depending on how frequent and fierce typhoons are in the locality. What is important is that there should be available space of at least 900 cubic meters for every hectare planted.

Because of saprophytic fungi attacking the leaves in the shed when it gets too humid (more than 84 per cent relative humidity) it is often necessary to heat the curing shed until the danger is past. As the shed contains leaves, the draft and heat should be kept under control so that the slow and natural drying of the leaves will not in any way be either hastened or retarded.

*Fermentation.*—When the leaves have completely cured, that is, even the midribs are completely dried out and they are in the so-called "neither dry nor moist condition," they are ready to be unstrung, bundled into 50's and piled for fermentation.

Owing to their fine texture, they can stand greater heat to advantage than any other type of tobacco, the lowest being 56°C. The Sumatra method of fermenting whereby a lot of leaves weighing from 1,000 to 2,000 kilos are initially bulked and gradually combined arithmetically 3 times ought to be sound practice inasmuch as it is generally followed in that island.

But in the tobacco stations of the Bureau of Plant Industry where wrapper tobacco could never be raised on a commercial scale it has been shown that with small piles, 2 by 2.5 meters and the height equivalent to 29 to 30 layers, wrapper tobacco can be allowed to heat to 56° C. without any adverse conse-

quences. The fermenting piles should, of course, be rebuilt the moment the desired temperature has been obtained reversing the position of the leaves in order to insure uniform fermentation of all the leaves in the pile.

*Preparation of product for the market.*—After fermentation the leaves are to be sorted on the basis of color, soundness and size: bundled into 25's and 40's and baled with the cheapest mattings like pandan, available locally. Every bale should contain 50 kilos of wrapper leaf tobacco not only in compliance with Internal Revenue regulations but for convenient handling.

## ILLUSTRATIONS

PLATE 1

FIG. 1. An individual plant of the Viscaya variety.
2. An individual plant of the Simmaba variety.

PLATE 2

FIG. 1. A good stand of tobacco seedlings of the Simmaba variety 45 days old ready for transplanting.
2. A plantation of shade-grown Sumatra, Los Baños Economic Garden, Los Baños, Laguna, harvesting practically through. The tent used is of abacá cloth.

PLATE 3

FIG. 1. A partial view of an open-grown Sumatra plantation, Central Experiment Station, Bureau of Plant Industry, Manila. Note the vigorous stand of the plants.
2. An ideal curing shed for wrapper leaf tobacco. The curing shed should be provided with adequate ventilations.


1


2

**PLATE 1.**

1

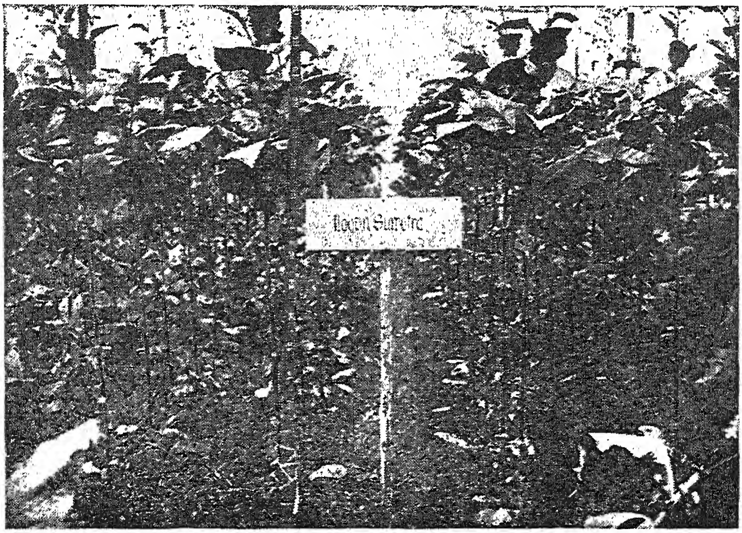


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PLATE 2.

1

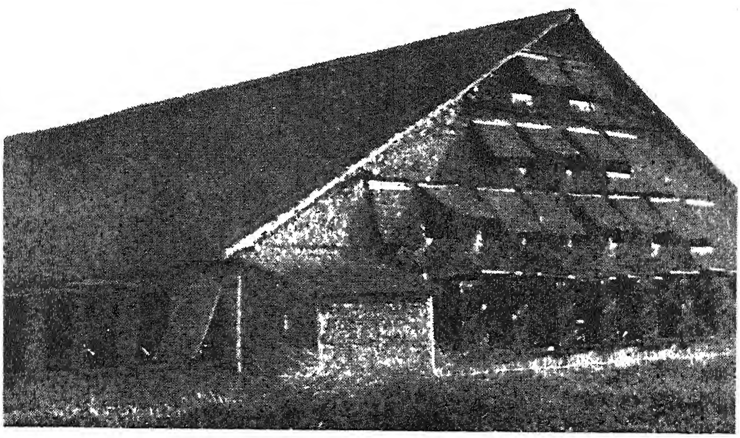

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PLATE 3.

# CONTROL OF INSECTS AND OTHER PESTS

Farmers' Circular 20—Revised

By GONZALO MERINO
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and

FAUSTINO Q. OTANES
*Assistant Chief, Plant Pest and Disease Control Division*

TWELVE PLATES

## INTRODUCTION

The objects of this circular are to help acquaint planters with the different methods of combating plant pests, insects in particular, and to give directions especially on the application of the most common insecticides. This work also acquaints them with some of the new substances which have been found to be more or less satisfactory substitutes for arsenical compounds. In short it is intended as a plant pest control guide to planters in particular.

The many methods employed for the control of plant pests, of which insects are the most numerous and the most important, are usually grouped by authors into two classes, namely, the direct and indirect methods. The first group consists of the use of chemicals in the form of spray, dust, fumigants, repellants, etc., killing the pests by beating, burning and other mechanical means. The second consists of cultural measures, such as crop rotation, use of resistant varieties, use of parasites, birds and other natural enemies, etc.

In the control of insects and other pests, all possible methods should be employed. Some people are apt to think chiefly of chemical control, spraying, for instance, whenever their plants or crops are troubled by certain pests, forgetting that such methods as handpicking, collecting the insects by means of certain devices, cultural measures, taking advantage of the help of natural enemies, etc., are also productive of results when judiciously employed. Others also wish for such things as "viruses" with which plant pests may be inoculated and thus wiping these out, as if by miracle. While insects and other pests, like other living

things, are attacked by fungi, bacteria, insects, etc., these parasitic organisms are useful only to a certain extent and should not be expected to do the whole job. Still other people think of certain compounds which may be injected into plants and thus make these at least disagreeable to pests and thus keep them away. Let the public be warned about using advertised compounds alleged to possess such power. They have been found to be worthless and even injurious to plants.

It is important that one should have a knowledge of the nature, the life history and habits of the pest intended to be placed under control in order to be able to apply intelligently, effectively and profitably the measures against it. One of the things, for instance, that one should know is how an insect, for example, injures the plant—whether it bites the plant or suck the juices. The choice of the right chemical to use depends on these. Other things that should be known are: (1) where and how the insect lays its eggs, (2) how the young live and how long it takes them to become adults, (3) where the adults spend most of their time, (4) what other food plants they have, etc. The aim is to know the "weak spots" in the life of the pest so that efforts may be directed against those "weak spots" and thus more effectively control the pest. These data in connection with any pest may be obtained from the Bureau of Plant Industry and if not available the Bureau may secure them by conducting the necessary research work.

## CHEMICAL METHODS (INSECTICIDES)

**STOMACH POISONS (For killing, biting or chewing insects, such as "worms" or caterpillars, beetles, grasshoppers, etc. See Plates 3, 4 and 5).**

*Calcium arsenate powder* (*basic*).—The amount to use is from 1.8 to 3 grams per liter of water, or 8 to 14 spoonfuls (levelful) to every petroleum canful of water depending on the plant and on the tenderness of the leaves of the plant. The spray should be *stirred well before, and now and then, during the spraying. A pump with a good nozzle that will deliver the spray in a fine mist* should be employed. A bucket pump, preferably one with an air chamber, may be used. It should have a rubber hose of convenient length and with a good nozzle that will deliver the spray in a fine mist. This will serve the purpose. In spraying tall trees, a bucket pump should be provided with a long rubber hose. In order to spray the highest parts of the trees, the end of the hose should be tied to the end

of a pole long enough so that the operator can raise the end of the hose and thus spray all the upper parts of the trees.

For spraying commercial orchards, it may prove more economical and will certainly be more effective to use a power spray or a barrel pump mounted on a cart or sled.

For spraying vegetables and ornamental trees and low trees, a compressed air sprayer or a knapsack sprayer is very convenient, as either one can be operated by one person.

Calcium arsenate may also be used for dusting, either pure or mixed in the proportion of one part of calcium arsenate to 1 to 5 parts by volume of "gawgaw" (cassava starch) or other fine carrier. The two should be mixed thoroughly. It is preferable to dust in the morning or late in the afternoon. For dusting, an ordinary rice gunny sack or a cheese cloth or "sinamay" bag may be employed. However, it is better to use an ordinary crank or bellow duster, which can be purchased from hardware stores in Manila. A clean, dry wide-mouthed bottle or a clean tin can or bamboo joint can be used for dusting plants, like garden and ornamental plants. The mouth of any one of these containers should be covered with "sinamay" or cheese cloth which allows the powder to pass through easily. It is not advisable to dust when there is a strong breeze, as much of the powder will be lost.

*Lead arsenate powder* (*basic*).—Like calcium arsenate, lead arsenate is used for killing "worms" or caterpillars, beetles, grasshoppers, and other biting insects feeding on the leaves of trees and vegetables. The amount to use is 2.3 to 4 grams per liter of water, or 6 to 12 spoonfuls (levelful) to every petroleum canful of water. The spray is applied like calcium arsenate. For spreader, a small quantity of soft, yellow laundry soap may be used—say 3 to 5 grams soap per liter of water. The soap should be dissolved first and the lead arsenate added thereafter. If there are plant lice or other sucking insects, the amount of soap may be increased.

### LEAD ARSENATE FOR DUSTING

Like calcium arsenate, lead arsenate can also be used for dusting, either alone or mixed with a carrier in the proportion given for calcium arsenate, that is one part of lead arsenate to 5 parts of the carrier by volume. The amount of carrier may further be increased, for the sake of economy, if trials show that a weaker mixture will satisfactorily control the pest concerned.

Both calcium arsenate and lead arsenate (especially the former) are widely employed in the Philippines for controlling such pests as tomato worms (*Heliothis assulta*), the 28-spotted beetle (*Epilachna 28-punctata*) and cabbage worms (*Crocidolomia binotalis* and *Plutella maculipennis*). A fifty-fifty mixture (by volume) of calcium arsenate and "gawgaw" is extensively employed for dusting against locust hoppers, *Locusta migratoria manilensis* Meyen, (Plate 6) while roosting on grass, sugar cane, etc., and armyworms, like the grass armyworms, *Spodoptera mauritia.*

*Paris green.*—Paris green is seldom used now for spraying, but if available, it may be employed according to the following standard formula:

| | |
|---|---|
| Paris green | 150 grams |
| Quick lime (unslaked) | 450 grams |
| Water | 190 liters |

On a small scale the following formula may be used:

| | |
|---|---|
| Paris green | 2.5 teaspoonfuls |
| Quick lime | 5 teaspoonfuls |
| Water | 1 petroleum canful |

The lime should be slaked first and then the Paris green is added and the two mixed thoroughly. The necessary amount of water should be added and the whole stirred before, and while, spraying.

Paris green can also be used for dusting by mixing it with a carrier, such as "gawgaw" or ordinary inert lime, in the proportion of 1 part of Paris green to 10 to 20 parts by volume of the carrier. The two should be mixed thoroughly. A dry barrel or a drum (such as an empty calcium arsenate or lead arsenate drum) with a tight-fitting cover may be used for mixing. The ingredients should be put into the barrel and this is closed afterwards and then rolled as long as possible until the ingredients are thoroughly mixed. A dozen or more good-sized gravels or stones put into the barrel with the chemicals will facilitate the mixing during the rolling. A barrel mounted on axles and provided with a handle will make a convenient apparatus for mixing arsenicals and other dry insecticides with their respective carriers or fillers.

### PARIS GREEN AGAINST WHITE ANTS OR "ANAY"

Paris green has been, and is being employed, in other countries, and in the Philippines to some extent, for combating white ants or termites. The powder is applied into the galleries,

runaways, or covered passages of the insects by means of suitable blowers or duster. The powder sticks to the bodies, legs and antennae of the insects and when they lick each other they accidentally swallow some of the poison and when they return to their nest they may also poison the others and possibly the queen and young also.

Paris green should be applied directly into the nest when this has been located.

### SUBSTITUTES FOR ARSENICALS

There are now certain compounds that are used as subsitutes for arsenicals. Among these are the so-called cryolites, of which there are different forms. Other compounds are sodium fluosilicate, barium fluosilicate and derris, etc.

The objections commonly raised against arsenicals for application on fruit trees and vegetables, because of the residues, have prompted the search, especially in the United States, for other compounds which are not or are less poisonous to man and whose residues are easier to remove from fruits.

Among other new compounds, which have been tried by chemists of the United States Department of Agriculture are nicotine oil emulsions, nicotine bentonite and peat mixtures, diphenylamine (a common aniline derivative) and phenothiazene, which is said to be a compound of carbon, hydrogen, nitrogen and sulphur. Phenothiazene is said to be prepared by mixing diphenylamine and sulphur. The directions for using each of the cryolites and fluosilicates as a dust or as a spray, as the case may be, are usually given on each package or container.

*White arsenic powder* (*commercial*).—White arsenic is not safe for spraying plants. One of its uses is for poisoning rats. The poison may be applied in several ways. It may be mixed dry in the amount of two to four spoonfuls (levelful) to a chupa of boiled rice (about one condensed milk canful) boiled and mashed camote or shredded coconut, or with a mixture of any of these, the whole to be thoroughly stirred so as to insure an even distribution of the arsenic. The bait should be placed in bamboo tubes (large enough for the big rats to get into) when there are loose domestic animals or when it is raining. Chickens will be poisoned if they eat this bait. The bamboo tubes with poisoned bait inside should be placed where the rats pass or at the entrance to their burrows or mounds or in the infested field. The poisoned bait should be set late in the afternoon. Another method is to split a ripe banana, boiled

camote, or section of sugar cane and on the split surface a quantity of the poison is applied after which the halves should be pressed together as formerly. These articles should be placed singly about the fields where the rats are present.

When the rats are in burrows either carbon bisulphide or calcium cyanide, as mentioned later in this work, may be employed for killing the rats therein. The holes should be closed firmly with earth after the chemical has been applied in order to prevent the escape of the gas.

### WHITE ARSENIC FOR BAITS FOR INSECTS

White arsenic powder is very commonly used with baits for locusts, cutworms, armyworms, crickets, mole crickets, etc. However, Paris green may also be used.

Formula

| | |
|---|---|
| Rice bran | 4 petroleum canfuls |
| White arsenic (or Paris green) | 1 salmon canful |
| Molasses mixed 50–50 with water (by volume) | Add enough of the molasses and water little by little and mix with a clean shovel or other suitable tool until the whole is uniformly moist (not mashy). 10 to 20 salmon canfuls of the diluted molasses are usually enough. |

The bran and the white arsenic (or Paris green) should be mixed thoroughly before the molasses is added. The poison bait should be scattered or broadcasted in the places infested, preferably late in the afternoon, in the case of cutworms, armyworms, crickets and mole crickets. In the case of locusts, the bait may be applied either late in the afternoon or early in the morning and around the places where the locust hoppers (nymphs) roost for the night. The bait may also be applied on trails and on relatively clean or barren grounds through which the hoppers are marching.

For locusts, fine bagasse has been found to have given better results than rice bran. But in the absence of rice bran and bagasse, sawdust has also been found to be a good substitute.

Baits should be applied soon after preparation as they deteriorate and lose their effectiveness with age. Care should be taken that domestic animals do not get access to the poison bait, as well as to grass dusted with arsenicals.

WHITE ARSENIC FOR WHITE ANTS OR "ANAY"

The use of Paris green against white ants has been described. White arsenic may be employed instead of Paris green for the purpose.

*White arsenic for wild hogs.*—White arsenic may also be used against wild hogs and "camote" or sweet potato may be used as bait. Holes should be bored into the potatoes. The holes should then be covered tightly with camote parts or borings so as to prevent the white arsenic from falling off. The tubers should then be put in places frequented by the hogs.

Another method of using white arsenic against wild hogs is to mix it with molasses and rice bran ("darak") and the mixture is applied or mixed with bait.

SODIUM ARSENITE

Like white arsenic and Paris green, sodium arsenite is commonly used in other countries as a poison for baits for locusts and grasshoppers. As a dust it has also been found to be effective (chiefly as a contact poison) against locusts.

Sodium arsenite is also commonly employed for poisoning sugar solutions for killing ants. The amount to use is 8 to 10 grams of sodium arsenite dissolved in 1 liter of water with about ½ kilo of sugar. If available several spoonfuls of honey may be added to make the bait attractive. The bait may be put in shallow dishes or in cans with perforated covers and these placed along the paths of the ants.

SODIUM FLUORIDE

Sodium fluoride is effective against cockroaches. This should be dusted in crevices where the cockroaches are hiding or on the places frequented by them. Some of the powder sticks to their bodies, legs and antennae and when they lick themselves they accidentally swallow some of the poison.

*Every precaution should be taken so that none of the arsenicals and other poisons does injury to human beings and domestic animals.*

CONTACT POISONS **(For the control of sucking insects, such as plant lice, scale insects, including mealy bug.** See Plates 1 and 2).

*Powdered soap or soft yellow laundry soap.*—The amount to use is from 10 to 30 spoonfuls (levelful), in the case of powdered soap, and from 150 to 400 grams in the case of soft, yellow laundry soap, for every petroleum canful of water.

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The powdered soap can be dissolved by stirring vigorously. The ordinary laundry soap can best be dissolved by boiling. A pump with a good nozzle that will deliver the spray in a fine mist should be used. The parts of the plants affected should be wetted thoroughly so as to be sure the insects are moistened. The soap solution enters the breathing organs of the insects and thus kills them by suffocation and possibly, injury of the breathing organs and blood cells.

If biting insects are present, lead arsenate may be added, at the rate of 6 to 12 spoonfuls (levelful) to every petroleum canful of the soap spray. The solution should be stirred well, before and often, while spraying. The solution will also kill ants and other biting insects, if made strong enough. Soap solutions have been found effective against the hoppers of the migratory locust, coconut leaf miner beetles, (*Promecotheca cumingi*), mango hoppers (*Idiocerus clypealis* and *Chunra niveosparsa*), etc. For the last named insects 4 to 6 grams of soap per liter of water (or an average of 1/10 kilo per petroleum canful of water) have been found sufficient without apparently injuring the mango flowers.

*Plants that are flowering had better not be sprayed until one has tried by repeated trials that the soap spray, or any other spray, does not injure the flowers.*

### KEROSENE EMULSION

This is one of the commonest insecticides for sucking insects and is easily prepared.

*Formula:*

| | |
|---|---|
| Kerosene | 8 liters |
| Laundry soap | 0.3 kilo |
| Water | 4 liters |

A petroleum can can be conveniently used for preparing the emulsion. The soap should be cut into small pieces and dissolved in the water by boiling. After the soap has all been dissolved, the can should be taken out of the fire and the kerosene added little by little and at the same time stirring the solution vigorously. A bucket pump is best used for the purpose. The liquid should be continuously pumped back into the can until the soap and kerosene are well emulsified—that is when a uniform white, creamy liquid has been obtained.

For spraying against plant lice and other sucking insects, one part of the stock solution to 8 to 16 parts of water by volume may be used.

*Lime sulphur.*—This is used for controlling scale insects, mites, and lichens. However, it will also control plant diseases, such as leaf spots on fruit trees, etc. Although lime sulphur is chiefly used as a contact poison, it has also repulsive effect against certain insects and other pests.

A formula for preparing ordinary self-boiled lime-sulphur is as follows:

| | |
|---|---|
| Unslaked lime | 2.5 to 0.3 kilo |
| Sulphur (pulverized or ground sulphur | 2.5 to 0.3 kilo |
| Water | 20 liters (about one petroleum canful). |

The lime should be slaked first by adding water little by little so as to convert it into a paste. After the lime has been slaked, the sulphur should be added immediately and the two mixed thoroughly, adding more water if necessary. Thereafter, the required amount of water or 20 liters (about one petroleum canful or 5 gallons) should be added and the whole stirred thoroughly. The liquid should be allowed to pass through a strainer before spraying.

Another formula which has been used by the Bureau in the absence of unslaked lime is as follows:

| | |
|---|---|
| Ordinary lime (air slaked) | 2 kilos |
| Sulphur | 2 kilos |
| Water | 10 liters |

The lime and the sulphur are mixed together and the necessary amount of water is added. Then the mixture is boiled for one hour or more until a clear amber colored liquid is obtained. The water that has been lost during boiling should be replaced. Then straining follows in order to free the liquid of any particles which may interfere with the spraying. The residue or lime-sulphur sludge is good for painting trunks of trees for the treatment of "gummosis" and as a repellant against bark borers. If a Beaumé hydrometer is available, the reading for the stock solution should be taken and the dilution for spraying should be made in accordance with the reading.

In the absence of a hydrometer, however, one part of the stock solution may be diluted with 20 to 30 parts of water by volume.

Lime sulphur should not be mixed with soap solution spray, as the two form a precepitate which will clog the nozzle of the spray pump.

*Dry lime sulphur (powdered or dry form of lime sluphur).*—For controlling scale insects, mites, lichens and plant diseases, particularly those attacking the leaves, shoots and fruits.

From 7 to 15 spoonfuls (levelful) per petroleum canful of water are usually sufficient. Directions are given by the companies selling the dry-lime sulphur powders. The sulphur powder should be added to the water little by little and the latter should be stirred vigorously while the sulphur is being added in order to dissolve the chemical. A good pump as in the case of fungi-bordo should be used. Spraying may be done at least once a month or as many times as the case may require. Calcium arsenate may also be added if the plants are at the same time attacked by biting insects, using from 10 to 12 spoonfuls (levelful) of the chemical for every petroleum canful of the lime sulphur spray. *Soap and lime sulphur* should not be mixed.

*Carbolineum or lime sulphur sludge.*—For the control of bark troubles due to insects and fungi the affected parts should be scraped off and cleaned and then painted with carbolineum or lime sulphur sludge. Lime sulphur sludge is the residue that is obtained in the preparation of ordinary lime-sulphur concentrate. *Carbolineum* should not be applied *on fresh tissues or unaffected parts.*

### DERRIS

For the control of both biting and sucking insects other substances may be employed. One of these is derris. Certain manufactured compounds are available. However, fresh derris or "tubli" roots may be employed. One-half to one kilo of fresh derris roots is used for every petroleum canful (5 gallons) of water. The roots should be pounded and then soaked in the water for at least three hours, better overnight. The infusion should be strained before it is used.

Dried or fresh derris roots may be used against certain caterpillars and plant lice on cabbages, pechay and other leaf crops. To increase the effectiveness of the spray, soap should be added as a sticker or spreader, using at the rate of 3 to 5 grams per liter of the derris spray.

Derris powder is now available at the Bureau of Plant Industry, Manila. This can be used for dusting and spraying not only against plant lice but also against biting insects, such as cabbage caterpillars (with the exception of the common cutworm, *Prodenia litura*) leaf eating beetles, locusts, grasshoppers, etc. Derris dust is preferable to arsenicals, for it is not poisonous to humans when ordinarily employed as an insecticide. Fine derris dust containing about 3 per cent rotenone is used as a spray at the rate of 2 to 6 grams per liter

of water or of soap solution (or ½ to 1½ spoonfuls per liter or 10 to 25 spoonfuls, levelful, per petroleum canful of water or of soap solution).

Derris dust is also effective against fleas. It should be dusted and rubbed in on the bodies of dogs or cats infested. It may also be dusted on infested premises.

*Pyrethrum.*—Pyrethrum insecticides are made from the flowers of certain chrysanthemums. They are very effective against plant lice, certain caterpillars and other insects, such as mosquitoes, bedbugs and ants. For ants in the house, pyrethrum is most recommendable, as there is no danger of poisoning persons.

Pyrethrum powder is obtainable from local drug stores under certain trade names.

*Tobacco water or decoction.*—This is sometimes used against aphids, if nothing better is available. It is prepared by simply soaking enough wasted tobacco, such as tobacco stems, midribs, leaves or dust, etc., in water, hot water being preferable, until a decoction with the color of strong tea is obtained. The decoction is then strained, if necessary. For spraying, one part of the decoction to 5 to 10 parts of water by volume is used. The dilution may be made less if desired. It will give better results if used with soap, using from 4 to 6 grams of this for every liter of the diluted decoction (about ¼ pound of soap to one petroleum canful of the diluted decoction is enough).

*Nicotine sulphate.*—Nicotine sulphate, a commercial preparation from tobacco, is a powerful contact poison especially for aphids or plant lice. It is used extensively by florists and gardeners in the United States. This insecticide, 40 per cent strength, is usually used for aphids in the proportion of 1 part to 800 parts of water. For other pests such as scales and mites the amount of nicotine sulphate may be increased.

It will give better results if it is used with soap, Chinese yellow soap, for example, as a spray. A good mixture for dusting vegetables can be prepared by mixing nicotine sulphate with ordinary lime. Fine starch, such as "gawgaw" can also be used.

FUMIGANTS (For both biting and sucking insects)

*Carbon bisulphide and calcium cyanide.*—For fumigating grains and other stored products, carbon bisulphide is effective and this is used at the rate of 10 to 20 pounds (approximately 3.7 to 8 liters) of carbon bisulphide for every 1,000 cubic feet of room space or volume. The "bodega" should be air-tight

so as to prevent the escape of the gas. *Care must be taken not to inhale the gas as it is poisonous.* It is also inflammable, so one must be cautioned against fire. Smoking should be prohibited during fumigation.

Calcium cyanide, which is in the form of powder, flakes, granules, etc. (commonly known as "Cyanogas"), may also be used for fumigation. This is employed usually at the rate of $\frac{3}{4}$ pound to 2 pounds for every 1,000 cubic feet of room space or volume. The chemical gives off hydrocyanic acid gas, *which is highly poisonous and should not be inhaled.*

Fumigation is employed against pests of stored products, fruits, plants and other materials, but an air-tight comparment is necessary to be successful.

Carbon bisulphide and calcium cyanide are also good for getting rid of ants or termites that have their nests in the ground. These chemicals are injected or introduced into the nests to kill the queens and young. They can also be used against root grubs and other soil insects.

For "bokbok" (*Bostrychids* and *Scolytids*) and "anay" (termites) that live in wood (dry wood termites) an admixture of paradichlorobenzene and kerosene is good. This has been employed by the Bureau for many years with satisfactory results. The amount to use is 200 to 250 grams paradichlorobenzene to every liter of kerosene. Let all the paradichlorobenzene crystals dissolve before using. The solution is good for applying into wood or furniture that is infested. A syringe or a medicine dropper may be employed in applying the solution.

Paradichlorobenzene crystals may be used as fumigants, especially against insects attacking herbaria, clothes, etc. Compared with carbon bisulphide and calcium cyanide paradichlorobenzene is practically harmless to human beings.

Another fumigant consists of a mixture of carbon tetrachloride (one part) and ethylene dichloride (three parts), by volume. Twelve to fourteen pounds of the mixture are usually used for every 1,000 cubic feet. This mixture has an advantage over carbon bisulphide in that it is *not inflammable.*

Other compounds that may be used for fumigation are nicotine, chlorpicrin, chlorine, etc.

The duration of exposure varies with the materials. In fumigating seeds, household materials, dried plant materials, etc., the exposure is usually from 24 to 48 hours. Plants and plant materials that are susceptible to injury are usually exposed

for one hour and for these hydrocyanic acid gas is preferable.

### REPELLANTS

As the name suggests, repellants are substances that are used for keeping away insects. The very odor of some of these repellants drives the insects away. Among the substances commonly used as repellants are tobacco dust, wood ashes, creosote, crude oil, petroleum, tar naphthaline, lime, etc. Some of these, as tobacco dust, crude oil and petroleum, also fall into one of the classes of insecticides already considered—the contact insecticides. Tobacco dust is a good aphicide or contact insecticide for plant lice or aphids. It is also sometimes used for repelling ants, like wood ashes.

Naphthaline is very often mixed with seeds for keeping away weevils and other insects.

Creosote is extensively used in the United States as a repellant against the Chinch bug which attacks wheat, corn and other crops. It is also extensively used for treating timber to prevent the attack of termites (white ants) or "anay."

Ordinary lime is used as a repellant against slugs ("lintang̃ lupa") and snails. It also kills these animals. The material is to be applied along the borders of plots or fields to be protected and in places where the slugs hide.

The leaves of certain wild plants, like "alagao" (*Premna odorata*) are used locally as repellants against chicken mites. Likewise the leaves of "lagundi" (*Vitex negundo*) are employed as repellants against certain insects such as the rice bug. The leaves of the local nettle plant, "lipang calabao" (*Laportea meyeniana*) are sometimes used in houses to scare away rats.

*Bordeaux mixture.*—This is used for controlling plant diseases, like canker and rust and other diseases occurring on the leaves shoots and fruits. However, since Bordeaux mixture is also known to repel certain insects, such as flea beetles, directions for using it are given here. It consists of copper sulphate, unslaked lime and water. A formula is as follows:

| | |
|---|---|
| Copper sulphate | 1.8 kilos |
| Calcium oxide (Stone lime, unslaked) | 1.8 kilos |
| Water | 190 liters |

"The amount of copper sulphate can be varied according to the formula given. The weight of stone lime should be equal to or exceed the weight of copper sulphate. The important point to

consider in regard to the materials is that good unslaked lime should be used. Bordeaux mixture cannot be prepared with air-slaked lime.

APPARATUS

Two half barrels with a capacity of about 115 liters, made by sawing in two a 230-liter barrel.
One 230-liter mixing barrel.
Two or more wooden pails.
One strong paddle, about 2 meters long.
One pair of hand scales.

PREPARATION

1. Dissolve 1.8 kilograms of copper sulphate in hot water, place in a half barrel, and add water to make 95 liters.
2. Slake 1.8 kilograms of stone lime in the second half barrel and add water to make 95 liters.
3. Mix solutions by having two operators, each provided with a bucket. Dip up equal amounts of the copper sulphate and lime solutions and pour them together, at the same rate, at a height of 6 to 90 centimeters above mixing barrel.
4. Mix the whole thoroughly by stirring vigorously.
5. Strain the mixture when putting into the spray tank.
6. Apply to the plants with a good pressure spray pump. Use as soon as made.

The preceding formula and directions for preparing Bordeaux mixture are from Reinking (Philippine Journal of Science, Vol. 13, A No. 4). There are other formulas. Smaller amounts of spray may be prepared in the proportions given in such formulas. What is important to remember is that there should not be any excess of copper sulphate, as this is liable to burn the leaves. A good test is to dip a clean knife into the spray. If the blade assumes the color of copper or copper is deposited, it indicates that there is an excess of copper sulphate and more lime should be added until the spray is neutral or slightly basic.

*Dry Bordeaux mixture.*—This is a very convenient substitute for ordinary Bordeaux mixture, which takes time to prepare. In view of the fact that it is in the form of powder it facilitates spraying.

Ordinarily from 15 to 40 spoonfuls (levelful) to every one petroleum canful (5 gallons) of water, depending upon the tenderness of the plant, are enough. A wooden container for the spray should be used, if possible. A half barrel with holders is satisfactory. Add the powder to the water little by little and stir vigorously to dissolve the chemical. Pumps with good nozzles should be used so as to make the spray come out in a fine

mist. Spraying should be thorough. The interval of spraying will depend upon the persistence of the disease. If the plants are at the same time attacked by biting insects, like leaf-eating beetles or caterpillars, calcium arsenate or lead arsenate, preferably the latter, may be added to the Bordeaux spray. From 6 to 12 spoonfuls (levelful) of lead arsenate for every petroleum canful of Bordeaux mixture spray may be used. *Care must be taken when plants are in flower. The flowers had better not be sprayed, unless one has definitely ascertained that the spray does not harm the flowers.*

*Whitewash.*—The application of whitewash on the trunks and branches of trees which will not injure the bark is known as good preventive against termites and bark and wood borers and the growth of fungi.

## CULTURAL AND PREVENTIVE METHODS

The value of prevention should not be overlooked. Attention should be called to the importance of planting good, disease and pest-free seeds and of seeing to it that the soil is fertile as in this way the production of vigorous resistant plants is insured. The seeds should be disinfected or fumigated, if necessary. Suitable, resistant and high yielding varieties should be used. Manure, green manure, humus or commercial fertilizers should be applied, if necessary. Other requirements of the plants, such as moisture, light, cultivation, etc., should be attended to, *as deficiency in essential requirements will make the plant susceptible to plant pests, as well as diseases.* One should see to it that his soil is not too acidic or basic and that this is corrected. Too much water in the soil is harmful to certain plants.

One should see to it also that the plant or crop he wishes to grow is suited to the climate in the region concerned.

Good plant sanitation and cultural practices, such as crop rotation, clean culture, should be adopted. For instance, any media, such as decaying vegetable matters, rubbish piles, etc., that are conducive to the breeding of certain pests should be disposed of. The coconut black beetle or "uang" (*Oryctes rhinoceros*), for instance, thrives and becomes very destructive where there are plenty of accumulated rubbish, manure, sawdust, dead coconut trees, etc., where it can lay its eggs. Get rid of weeds, as these often harbor insects and diseases. The destruction of infested fruits will help minimize the attack

of fruit flies, fruit borers, etc. Crop rotation and crop diversification should be intelligently practised.

Sick plants should be isolated or gotten rid of. Removing parts of plants that are affected will help. Cankery or scaly leaves, for instance, should be removed. Likewise affected twigs should be properly pruned or cut off.

Certain plants or varieties of plants may be utilized as "trap crops." The proper timing of planting will also minimize, if not prevent, the attack of certain pests. Thus beans planted late in October or early in November are likely to suffer less damage from the attack of the bean fly (*Agromyza destructor* Malloch) than those planted in December or later. This is also true in the case of cotton. When planted early before the beginning of the dry season, it is likely to suffer less from insect injury.

The planting of certain flowering plants is sometimes recommended to encourage the multiplication of certain parasitic insects, for the parasites feed on the nectars of the flowers of such plants. Thus the wasp parasites of root grubs are said to be encouraged in this manner. So are those of slug caterpillars on coconut and abacá, by the planting of flowering cover crops, such as *Calopogonium*.

## MECHANICAL METHODS

The use of other methods, such as handpicking caterpillars, collecting with different devices, trapping, etc., is effective in certain cases and should be employed. As a matter of fact, when these methods are timely and properly employed in certain cases, the use of insecticides, which cost money, may be dispensed with. The value of persistent collection is illustrated, for instance, by the case of the Citrus green bug (*Rhynchocoris longirostris*), which causes the falling off of citrus fruits in the Tanauan Citrus Station (Batangas). By persistent collection of the adults as well as the nymphs with the employment of nets with long handles, the pest has been kept in check there. Collecting the grubs, as well as the adults, has helped much in the control of the "toy beetle" (*Leucopholis irrorata*), the grubs of which attack sugar cane, rice and other plants (Plate 7).

The catching of locust flyers with nets and of hoppers by the corral and pit methods are effective especially in well populated provinces in Luzon and Visayas. Professional locust catchers, who sell the locust flyers in many provinces, are often of great help in wiping out locust swarms.

Light trapping, when timely employed, is also good against certain insects, such as the rice bug (*Leptocorisa acuta*), rice borer (*Schœnobius incertellus* and *Scirpophaga innotata*) and termite swarms. In order to secure the best results by the use of light traps in the control of rice borers and rice bugs, all the farmers in a locality affected should employ the method at the same time. They should begin setting up the traps early enough in order to catch the mother moths before they lay eggs on the rice plants. In coöperative control work like this, the services of the Plant Industry men in the province concerned should be availed of.

The use of tangle-foot or sticky preparations for catching and repelling certain insects is also good.

Bagging fruits to protect them from being infested by certain insects, such as fruit flies, moths, may save many a valuable crop, which would otherwise be lost if not so protected. The fruits of jackfruits ("nangka"), annonas ("ates," annona, etc.) and cucurbits ("patola," "upo," etc.), for example, can be saved in this manner. Ordinary pipe water applied with a strong pressure pump is at times effective in cleaning trees of certain insects, like plant lice and mealy bugs. Fire engines may be employed for this purpose, especially in public parks.

Flooding is sometimes employed against certain insects, such as armyworms, grubs, etc.

Fire is employed in certain cases. Thus burning grasslands is resorted to in the case of the locusts, especially hoppers. This method, however, should be used with care because of the danger of burning forests. The use of flames for killing ants is well known. Torches are sometimes used for killing certain pests, like rice bugs, mites, etc. There are in the market various devices for generating flames to kill locusts, weeds and other pests.

The use of heat to kill certain insects should be mentioned here. Steam heat, maintained at a temperature between 120° and 150° F for several hours, is often employed for killing insects affecting seeds, flour and other stored and manufactured products in grain houses, elevators and factories.

## BIOLOGICAL CONTROL

### USEFUL BIRDS, INSECTS AND OTHER ANIMALS

Everybody should help in the conservation and protection of insectivorous birds. Among these are the "martinez" (Chinese mynah) and the red-tailed shrike (locally known as

"cabezote," "tarat" and "pakiskis" in Tagalog; "panal," "palal" or "berdugo" in Ilocano; and "talimbalalas," "tibalas" and "tibas" in Visayan). Even the much maligned crow eats many destructive insects, more especially root grubs. Crows should not be indiscriminately killed. It is only when they are molesting poultry or destroying corn when something should be done to prevent, if possible, the limited destructions caused by them. Birds should be encouraged to nest on farms by the growing of suitable trees and providing them with houses for shelter where to nest in.

Many insects are useful, for they kill other insects, which are destructive. Indeed, parasitic and predatory insects are among our most important allies in insect pest control. Among these useful insects are the mantids and dragon flies. But by far the most important are the lady-bird beetles, which eat plant lice, scale insects and certain others. Certain wasps, the larvae of which subsist on the bodies of certain injurious insects, are equally important. Farmers in particular, should learn to recognize their friends and allies among the insects.

Toads, frogs, lizards and house bats also eat many injurious insects. It may pay to construct houses for bats, especially in large farms or "hacienda." Even pythons are beneficial for they eat rats. These animals, therefore, should not be unnecessarily destroyed. The common rice paddy frogs are edible and are caught in large numbers during the rice planting season. In view of their value as insect eaters, among the insects they commonly eat being rice pests, such as armyworms as proved by dissection by the Entomology Section of newly caught frogs, as many as twelve good sized worms having been found in one stomach, it seems advisable to regulate the catching season for frogs.

All concerned should at least also take cognizance of the importance of the work of scientifically trained men in connection with the search of parasitic and predatory insects and other useful organisms in other countries with the object of introducing the most promising of such organisms into the Philippines to control local pests, such as locusts, coconut leaf miner, cacao pod borer, etc.

## LEGISLATION

The enactment of certain laws and the promulgation of administrative orders in conformity with such laws are often resorted to as a means of controlling certain noxious insects. This is necessary in order to secure concerted or collective action against such pests and to safeguard the public welfare. As an example of a law of this kind may be mentioned the Locust Act No. 2472 in the Philippines which compels all male inhabitants in every municipality from 6 to 60 years to devote two days a week (working 9 hours a day) of gratuitous service in the combating of locust whenever there is an infestation. The services of these men can be utilized to the best advantage in the systematic application of poison baits. Another law is the Plant Quarantine Act (No. 3027), which aims not only to prevent the importation of foreign plant pests and diseases into the Philippines but also to prevent the spread of those that are already doing harm to the agricultural interests of the country. A number of specific administrative order has been promulgated in accordance with this Act in order that its purpose may be accomplished. One of these is that which prohibits the importation of all susceptible fruits from Mediterranean fruit fly infested countries. The old adage "an ounce of prevention is worth a pound of cure," applies with great force in plant quarantine work.

## HINTS AND PRECAUTIONS

Before any method of control is used, such as spraying or dusting, the approximate expenses and the probable profit that will be obtained as a result of the application should be carefully figured out. In the control of any pest, every practical method possible should be employed.

One should be sure that the trouble affecting his plants or crops has been properly diagnosed and that he has the right compounds or chemicals to use, if these are necessary.

One should have the proper equipment on hand, considering the kind or kinds of plants to be treated and the area involved. If one has a commercial orchard, perhaps the type he should have is a barrel pump or a power sprayer rather than a bucket pump, for the sake of economy in the long run. One should see

to it that his pumps are provided with the right kind of nozzles and other accessories and that they are properly cleaned after they are used. He should see to it also that the control measures used are timely applied and that the application is done at proper intervals, if necessary, until the pest or disease involved is controlled.

In preparing a spray, one should beware of over concentration. It is far better to make the solution or dilution weaker and increase the concentration, if it does not give the desired results, than making it too strong at once and injure or kill the plants. In case of doubt, it may be well to spray a few plants first to observe the effect of the spray both in pest or disease and on the plants, before a general or wholesale spraying is attempted.

If one fails to get the desired results with a certain method, he should *try to analyze the causes of his failure.* Perhaps he had better consult the Bureau of Plant Industry or its representative in his province, at least before employing other methods.

*Care should be taken in the use of arsenical poisons and fumigants in particular, as some of them are poisonous to human beings. When not in use, they should be kept in a dry and safe place where they are not accessible to children and irresponsible persons. They should be properly labeled "Poisons", with skull and bones drawn, if possible. After a prolonged dusting and spraying work with arsenicals, one should wash his hands very well and take a bath whenever possible.*

### FIRST AID REMEDY

With proper care there should not be any accident in connection with the use of poisons. However, in case of accidental poisoning through the mouth with an arsenical, the patient should be induced to vomit and then given the white parts (fresh) of eggs, followed shortly by a good laxative. Then the services of a physician should be employed.

### CONSULTATION

For further particulars regarding other plant pests and diseases, and sound agricultural practices in general, partly with the object of preventing the attack of pests and diseases, one may consult the Bureau of Plant Industry or its representative in his province.

If necessary specimens of the pest or disease complained about should be sent to the Bureau so that it may be identified and appropriate suggestions or recommendations as to control given. As to the necessary data to be furnished with specimens and as to the sending of these, Form No. 47 of the Bureau, copies of which may be had on request, should be consulted.

Before employing hired or professional service (which may entail considerable expense) in the control of any pests, such as white ants or termites ("anay") one may well consult the Director, Bureau of Plant Industry. The free advice and service of the Bureau may save him or her unnecessary expense. Perhaps with the information given by the Bureau about the pest—its nature, its habits, the extent of its ravages and etc.—one may apply the necessary control measures himself with local labor at considerably less expense.

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# ILLUSTRATIONS

## Plate 1

Fig. 1. *Sucking insects.*—Plant lice or aphids (*Aphis gossypii*) on cotton leaves. These aphids attack many other plants, such as citrus, melons, "pechay," etc. They and the other aphids can be controlled by spraying with soap solution in combination with nicotine sulphate or derris. Control work should start before they become very abundant. (After Otanes and Butac.)

2. *Other sucking insects.*—Mealy bugs (*Ferrisia virgata*) on mango fruits. They also infest many other plants, such as cotton, the different kinds of Annonas, gourds, etc. As in the case of aphids spraying with soap solution but of a stronger concentration can be used. The ants that attend to them should be destroyed. Mealy bugs are locally known as "dapulak" (Tagalog), and "aplat" (Ilocano).

## Plate 2

Fig. 1. Other sucking insects of the scale insect family on Citrus. These scales (*Parlatoria siziphus*) are very destructive to oranges, lemons, etc. Contact sprays, such as soap solution and lime sulphur, should be applied regularly against these and certain other kinds of scale insects.

2. Other examples of sucking insects of the true bug family. These insects are "vacavacahan" (*Dysdercus megalopygus*) in different stages—eggs, nymphs and adults. The insects attack cotton and other related plants. They also can be controlled by means of contact poisons, such as soap and derris. (After Otanes and Butac.)

## Plate 3

Fig. 1. *Biting insects.*—Cabbage caterpillars (*Crocidolomia, binotalis*). The pupal and adult stages of the same are shown. Stomach poisons, like calcium arsenate and lead arsenate, are effective against these. Derris powder can also be used.

2. A cabbage plant showing the work of cabbage caterpillars.

## Plate 4

Fig. 1. Other caterpillars (*Heliothis assulta*) on tomatoes. Spraying or dusting tomato plants with calcium or lead arsenate will control them. Apply control measures early and periodically, if necessary, to get results.

2. Showing different caterpillars on mango: at the left are "bagworms"; the two following are leaf rollers and the last two

are still different. All these not only attack the leaves but also the flowers. These can best be controlled by arsenical poisons. However, certain contact poisons, like derris, may also prove effective and should be tried.

PLATE 5

FIG. 1. *Another chewing or biting insect, a beetle.*—The coconut leaf miner, *Promecotheca cumingi*, and portions of coconut leaflets showing injuries by adult beetles and larvæ.

2. *Another biting insect.*—A weevil, the sweet potato weevil, *Cylas formicarius*, and the injury by it and its larvæ or grubs in a sweet potato tuber.

PLATE 6

*A national menace.*—The Oriental migratory locust (*Locusta migratoria manilensis* Meyen), another biting insect. Fig. 1 shows the different stages, egg, nymphs or hoppers and adult flyer. Fig. 2 shows the manner of laying eggs in the soil. From the date the eggs are laid to the time the insects become flyers takes about 70 days. Locusts as pests can not be entirely eradicated, but with sufficient funds their numbers can be greatly minimized by killing them in their breeding grounds, especially with the use of poison bait and arsenical dust. (Bureau of Agriculture illustrations.)

PLATE 7

Other biting insects, toy-beetles ("salagubang"), *Leucopholis irrorata*, and their grubs and pupæ. The grubs are among the most important pests of sugar cane, upland rice and other crops and the adults feed on the leaves of mango and other fruit trees. The pest can best be controlled by encouraging the multiplication of its parasites and killing grubs by means of poisons, such as carbon bisulphide, lead arsenate, etc. Collecting the grubs and the beetles by community efforts is effective. (After Otanes.)

PLATE 8

FIG. 1. Spraying with a compressed air sprayer, which is very handy and very convenient for plant pest and disease control in nurseries and flower and vegetable gardens.

2. Spraying mealy bugs on shade trees with a barrel pump. An apparatus like this is equally good for spraying fruit trees. Note the elevated platform built on the cart so the operators could properly spray all parts of the tree—a device likewise recommendable for orchards.

PLATE 9

An illustration of dusting with an ordinary hand duster (at left) and spraying with an ordinary bucket spray pump (at right). Note the long rubber hose provided and the advisability of tying the terminal portions of the hoses to long poles to reach the parts desired to be sprayed. (Bureau of Agriculture cut.)

PLATE 10

FIG. 1. Dusting vegetable beds with a contact poison dust (nicotine dust) to kill flea beetles by means of a bottle with "sinamay" cloth to allow the dust to pass through and in a regulated manner.

2. Showing method of dusting grassland with calcium arsenate by means of an ordinary rice gunny sack to kill armyworms (*Spodoptera mauritia*). In the absence of ordinary dusters, local devices, such as this, may be resorted to.

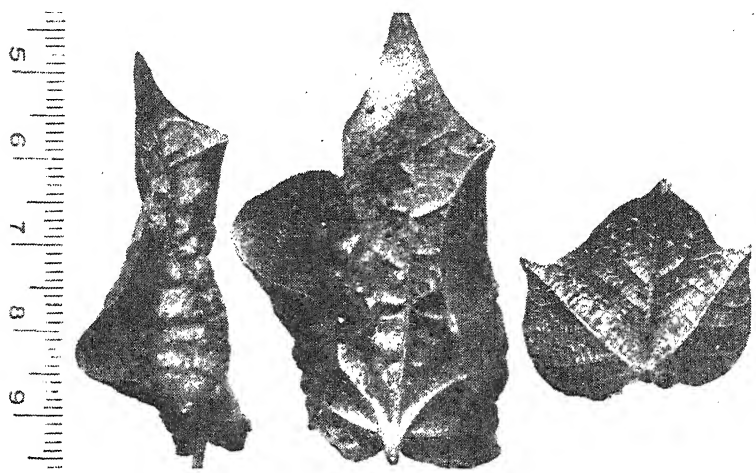
PLATE 11

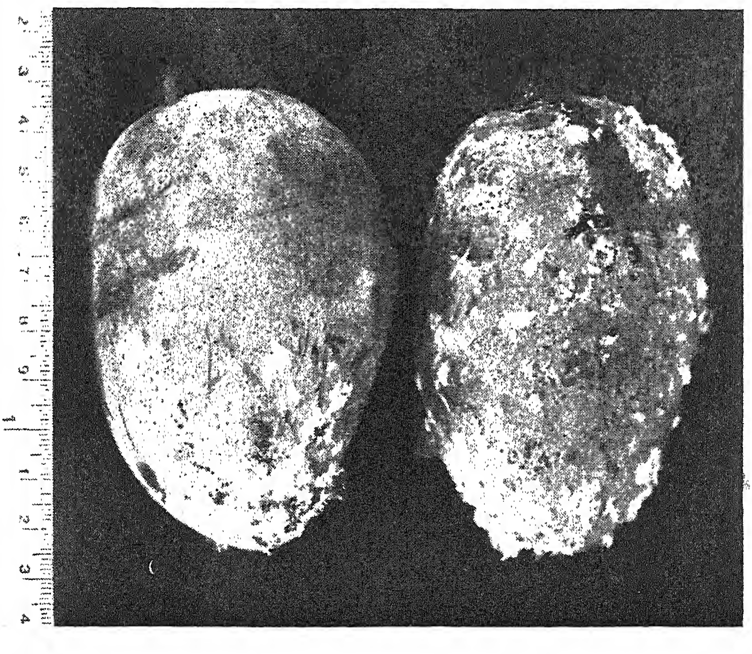
Spraying coconuts with soap solution by means of a power sprayer to kill leaf miner beetles. The whole apparatus is mounted on a cart and drawn by a tractor. Power sprayers are recommendable for use in commercial orchards and city parks. They may be mounted on carts or trucks.

PLATE 12

Some examples of beneficial insects, our allies in the control of pests among the insects. A small wasp parasitic on caterpillars, figure 1. Figure 2 shows a caterpillar with the eggs of this parasitic wasp, as indicated by the arrows; figure 3 shows a dead caterpillar with the larvæ of the parasites underneath; and figure 4 shows a full grown larva of the wasp. All figures are greatly enlarged. Figure 5 shows a bug which preys on boll weevil adults and mealy bugs and figures 6 and 7 show two kinds of ladybird beetles which prey on plant lice and perhaps mealy bugs also. (After Otanes and Butac.)

(Figs. 1 to 4, inclusive, are *Euplectrus manilæ* Ashm.; fig. 5 is *Geocoris tricolor* and fig. 6, *Chilomenes sexmaculata.*)



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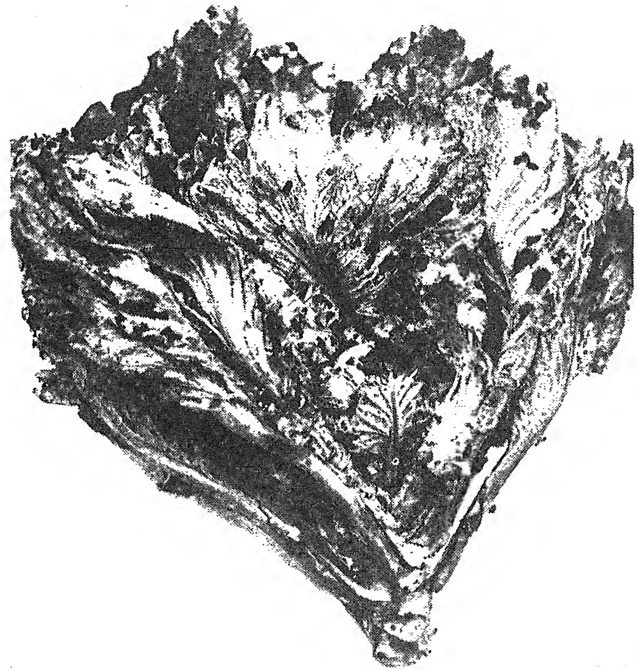

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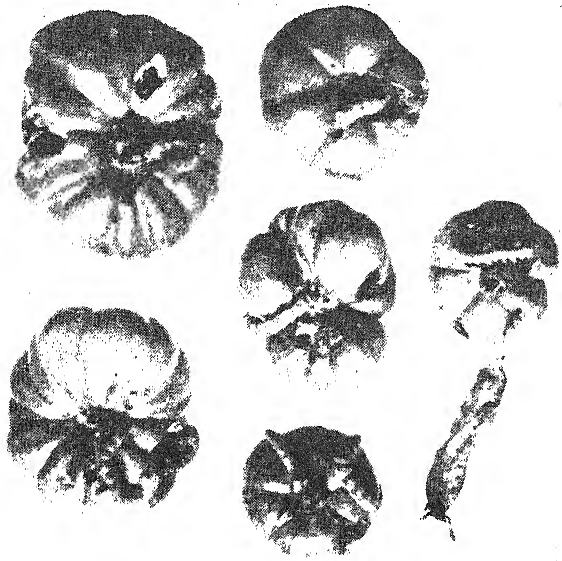

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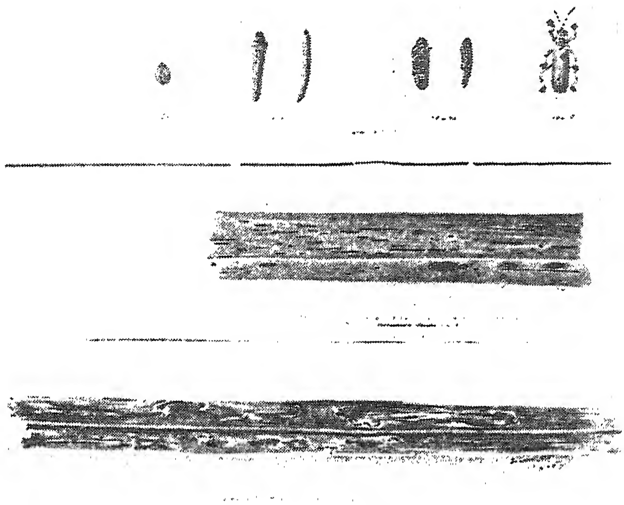

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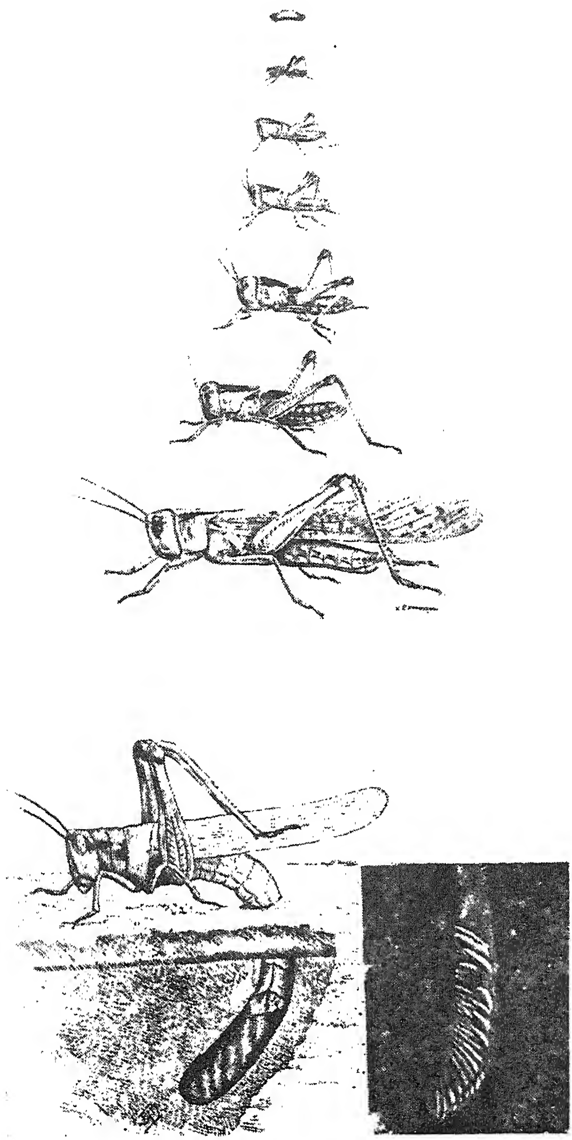

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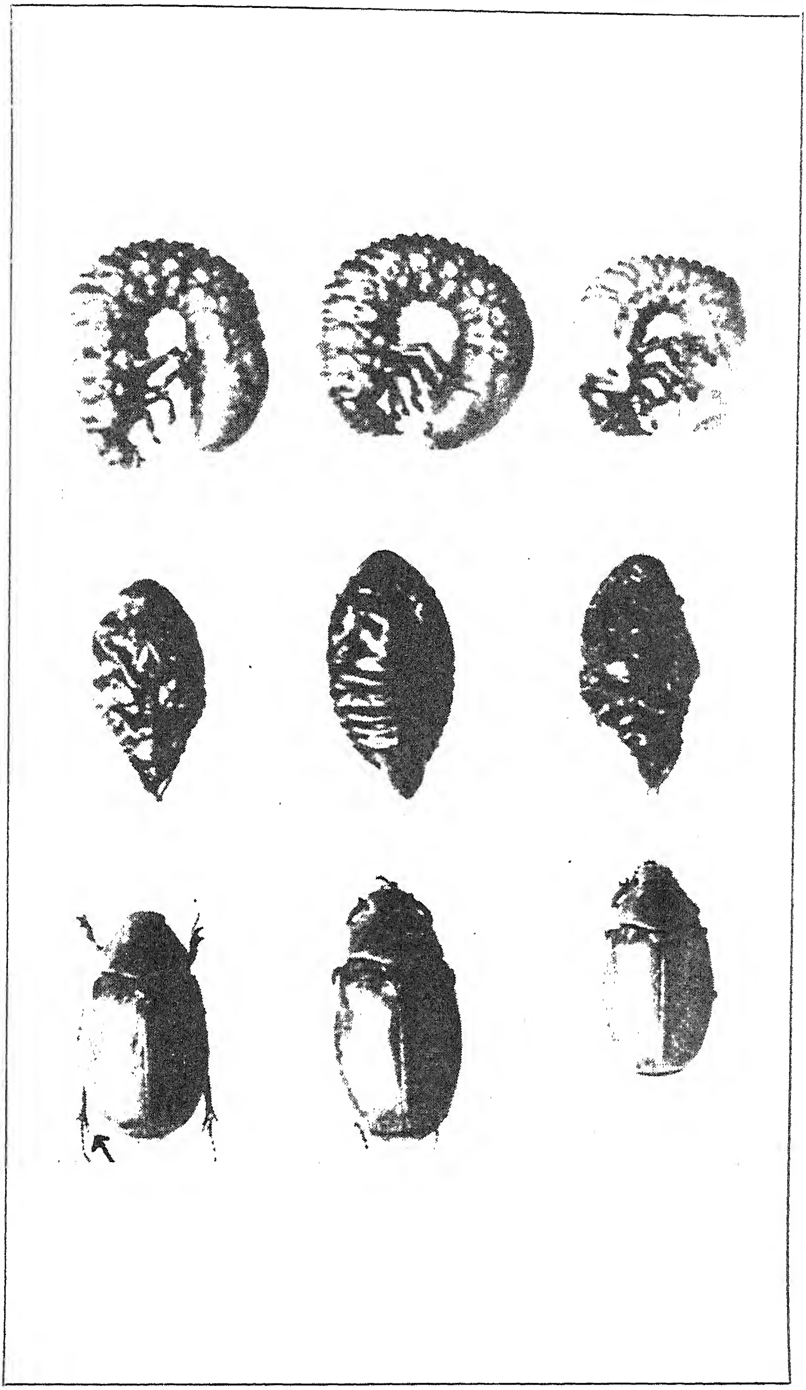

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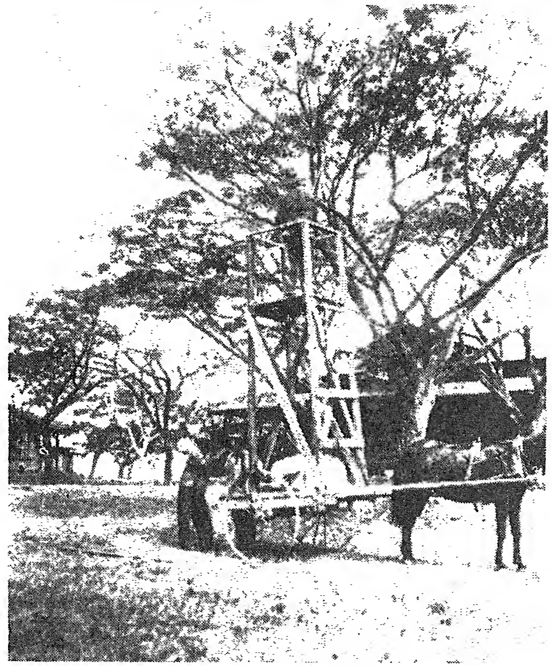

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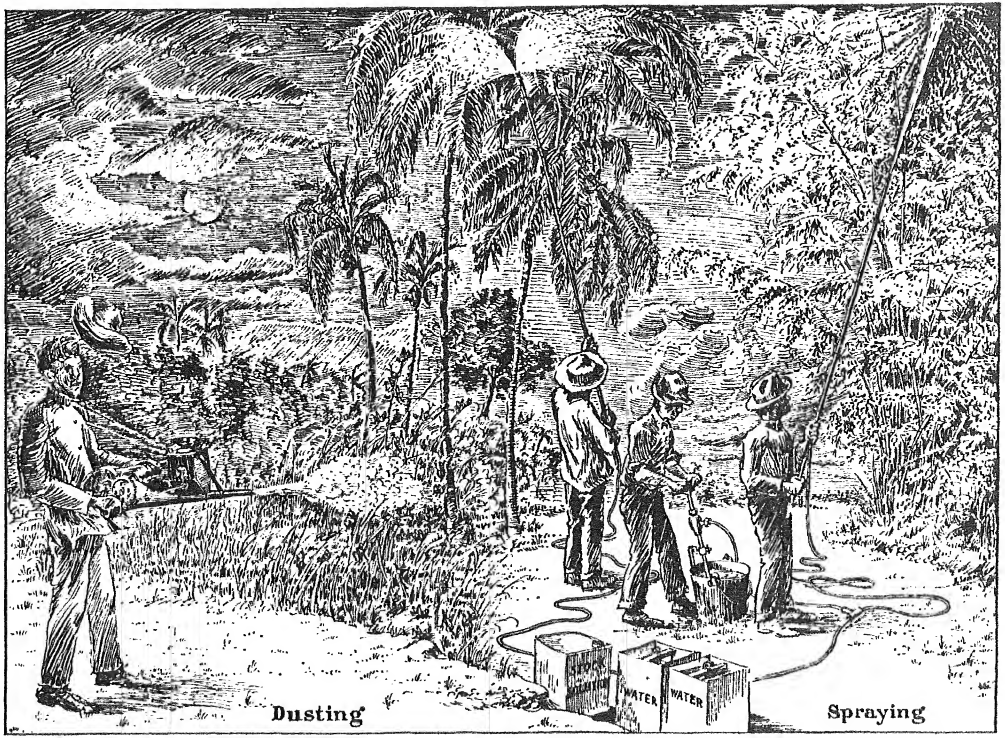


PLATE 9.

PLATE 10.

PLATE 11.

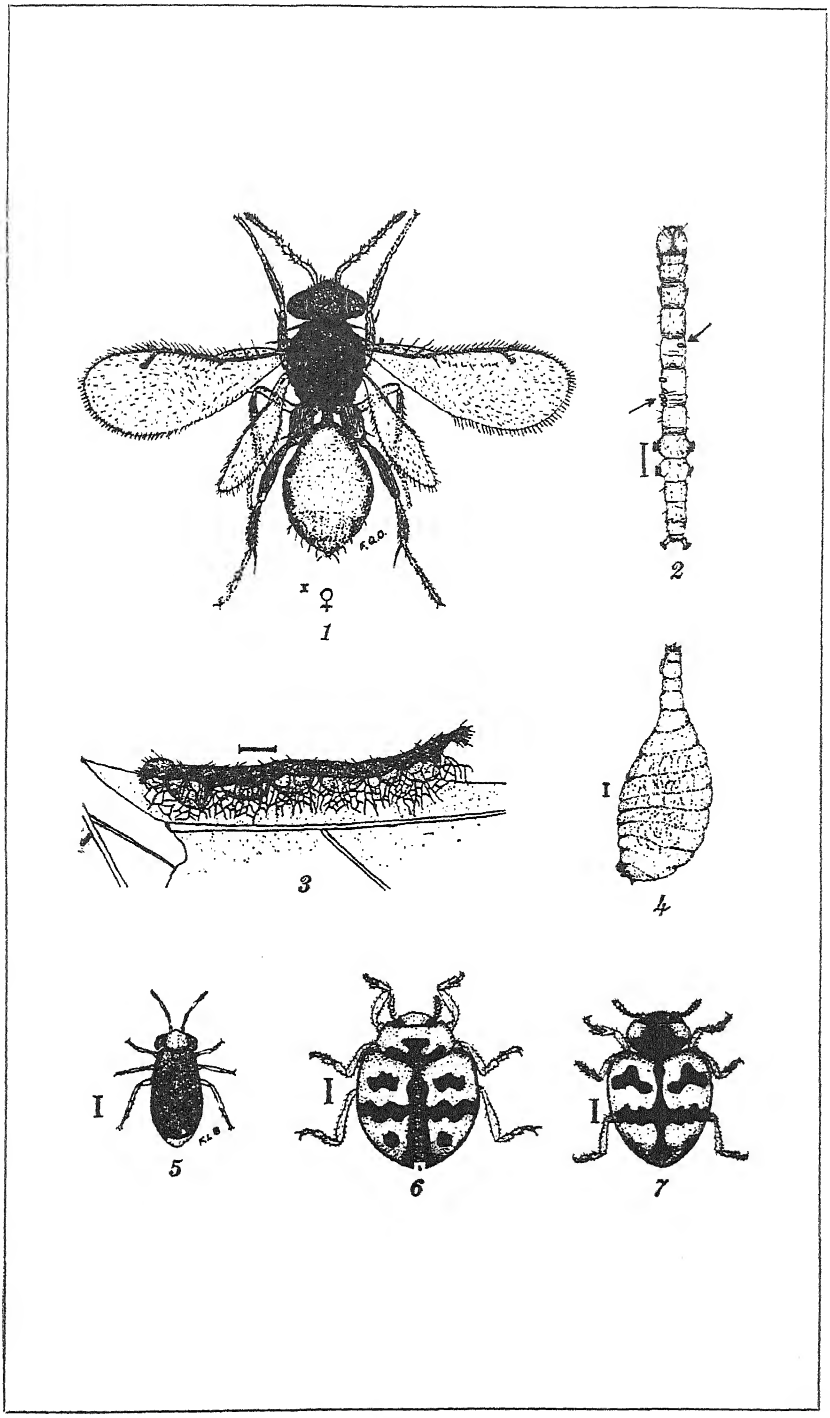


PLATE 12.

# THE RICE BUG AND ITS CONTROL[1]

Dialect Names: Atangia (Tagalog); Tiango, Piangao (Visayan); Dangao (Ilocano, Ibanag, Zambal); Dangeo (Pangasinan); Dongo (Pampango); and Tayangao (Bicol).

Farmers' Circular 30

By F. Q. OTANES
*Of the Bureau of Plant Industry*

ONE PLATE

The rice bug is one of the worst insect enemies of rice in the Philippines and other Asiatic countries. Farmers are so familiar with it that it is not necessary to describe it here.

The rice bug is destructive chiefly to varieties of rice that are planted early and which bear panicles late in September, during October or early in November. It has also been found destructive to varieties of rice planted during the dry season in places where dry season planting was not practised before, as in Pangasinan. One reason for such great damage is that there are only relatively small plantings of such varieties and all the bugs in the neighborhood being attracted there, they cause great damage on the crops, sometimes destroying them all. On the other hand, the injury they do to late varieties of rice is very slight, if any, per unit area, one reason being that the insects spread over a wide territory.

The bugs suck the juices of the grains during the milk stage, their mouth parts being well adapted for this purpose. Once the kernels of the rice have formed, however, they are no longer subject to injury by the bugs. Injured grains are usually empty and of a brownish color.

## LIFE HISTORY AND HABITS

During the months when rice is not growing or before any rice panicle appears, the insects feed and breed on wild grasses, but as soon as rice heads are available, the insects migrate to them as these are their favorite food.

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[1] Issued formerly as Circular No. 160 of the defunct Bureau of Agriculture.

Some farmers seem to believe that the rice bug together with other insects is engendered by the air rising from the soil instead of being born like other creatures, and are greatly surprised when shown egg masses and told that the bugs will come from these.

The eggs are dark reddish brown in color and are usually laid in groups of more or less regular rows consisting of one or two eggs on the leaves of the host plants. On rice the eggs are usually laid on the surface of the leaves a few inches from the tip. Occasionally eggs may be found on the rice panicles themselves. Since the eggs are dark reddish brown, they can be easily seen in the rice plants, once one has learned how to recognize them.

In about a week after the eggs are laid they hatch into young wingless bugs (nymphs) and these commence to feed on the host plants. The nymphs molt five times, after which they change into the winged or adult stage. The nymphal stage lasts about twenty days. The life cycle of the insect, therefore, from the time the eggs are laid up to the time the adults emerge, is approximately one month. Of course, the length of the life cycle would vary more or less in different places and is influenced chiefly by climatic factors, as temperature, humidity, etc.

## CONTROL MEASURES

### REMEDIAL MEASURES

1. Catching the insects by means of cloth nets or bags as is done in India. This can be easily done, for when the adult rice bugs are disturbed, they fly above the rice panicles and they can be caught with nets or bags without damage to the panicles.

2. Collecting the eggs and crushing them, or simply crushing them on the rice leaves with the fingers. It is better to collect the eggs for the resulting nymphs or young wingless bugs are just as voracious or more so than the adults. The eggs are attacked by small wasp parasites. Instead of crushing them, therefore, they should be collected and put in a bamboo tube or any suitable container and placed in a pan of water with kerosene. The object is to allow the wasp parasite of the eggs to fly and continue their beneficial work, and at the same time kill any young rice bug that may emerge from the eggs. The young rice bugs are wingless and, therefore, cannot fly. If they try to swim in the pan they will be killed because of the kerosene, and if they do not leave the container they will die of starvation.

3. Attracting them to lights at night. Large numbers can be exterminated by building fires near the paddies or on the dikes, or by burning bundles of bamboo sticks and going through the paddies with the burning bundles. The insects fly into the flames and are killed. Lanterns over basins containing water, to which has been added some kerosene or crude oil in order to cover the surface of the water, may be used. The stronger the light the better. In this method there is the cost of equipment and oil to consider. Light traps are most effective when there is no moonlight.

If these three methods are employed persistently from the time the first panicles appear up to the time the grains have already hardened, when they are no longer susceptible to attack, there will be little damage done by the rice bugs.

PREVENTIVE MEASURES

1. During the months when there is no rice or before the rice panicles appear, the bugs feed and breed on weeds, especially grasses. These are the right periods to kill the bugs. Clean cultures should be the rule. Destroy all weeds that serve as hosts for the bugs. Where the bugs are found abundant on these leaves, one good method is to cut these weeds leaving only a small area so that the bugs will gather there. They can then easily be caught with nets and killed, or sprayed with either soap solution and derris or dusted with derris as directed in this circular.

The land should be thoroughly prepared before the rice is planted in order to get rid of the weeds as much as possible. The essential requirements of the crop as to fertilization, irrigation, etc., should also be properly attended to.

2. As has been stated, the bugs are destructive chiefly to early varieties of rice. It is, therefore, suggested that either the planting of these early varieties be stopped, since they serve as breeding places for the bugs and may thus enhance the danger of their doing considerable damage to the late or regular season varieties of rice, or that the time of planting should be so regulated that these early varieties will flower at the same time as the late varieties. In this way the bugs will not concentrate their attack on any single field.

3. Dr. L. B. Uichanco, of the College of Agriculture, Los Baños, Laguna, observed that non-aromatic and bearded varieties of rice are less susceptible to the attack of the bugs. Other things being equal these varieties should therefore be planted

in preference to others. Observations should be made in each locality to find out what varieties of rice are entirely free from the attack of the pest.

The eggs and the bugs are preyed upon by other insects. These, therefore, are of help in the control of the rice bugs.

Although there are other methods that can be used to combat the insects, as spraying and dusting with chemicals, these methods should be used with caution because of the expenses involved. Chemicals should be employed at first under expert advice and supervision. One of these methods is spraying with soap solution, the amount of soap to use being one-fifth to one-third of a kilo to every petroleum canful of water. A one-man compressed or knapsack spray pump with a good nozzle is especially good for spraying. Care should be taken that the insects are well moistened with the spray.

A very effective remedy against the bugs is derris (tuble) dust. This is used at the rate of 2 to 6 grams or ½ spoonful to 1½ spoonfuls per liter of water (10 to 25 spoonfuls, levelful, to every petroleum canful of water). It is better if the derris is used with soap at the rate of 5 to 10 grams per liter of water (1/10 to ⅕ of a kilo).

Dusting with derries dust is also effective, but to get the best results, a good duster which can be bought from hardware store should be employed. Of course, an ordinary rice sack or a "sinamay" bag may be used, but the dusting would not be satisfactory, and a considerable amount of the dust is likely to be wasted.

Another method (a method recommended by the old Bureau of Agriculture) is attracting the adult bugs with decaying substances, such as rotten meat. This is put in a "sinamay" bag and is hung up in the infested field. The bugs gather on the bag to suck the juices of the rotting meat. They can then be killed by catching them with nets or by any other method which will not destroy or affect the attractiveness of the bait.

Instead of rotten meat, rotten fish, shrimps and mollusks have been employed in some places.

# ILLUSTRATION

PLATE 1. The rice bug

FIG. 1. Egg, side view.
2. Egg cluster on rice panicle.
3. First instar.
4. Fifth instar.
5. Adult.

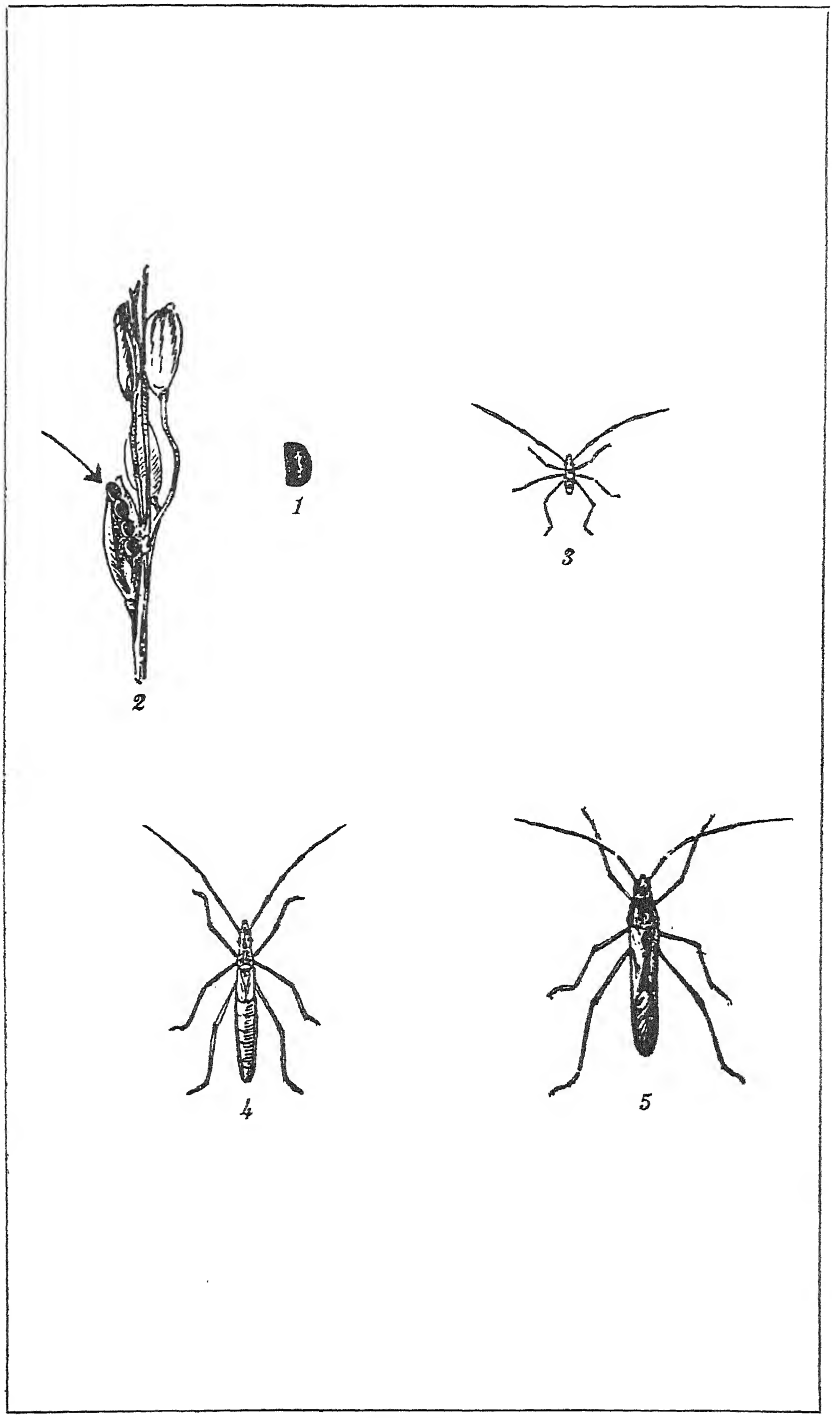


PLATE 1.

# RICE STEM BORERS AND THEIR CONTROL

Local Names: Accip na Pula or Apayang Pula (Tagalog); Guetaguet (Pangasinan); Igges ti Kayo Oenno Puon ti Pagay (Ilocano); Tomasoc (Visayan).

Farmers' Circular 31[1]

By F. Q. OTANES
*Of the Bureau of Plant Industry*

ONE PLATE

One of the most important pests of rice not only in the Philippines but also in other countries in the Orient, such as India, Japan, Burma, etc., is the rice stem borer—*Schoenobius incertellus*. As its name indicates, it injures the rice plants by feeding within the stalks, and is difficult to control by the application of poison. Since it can transfer from stalk to stalk, it is capable of destroying a considerable number of stalks before it reaches maturity. In the earlier stages of the growth of the plants, the injury results in the death of the youngest leaves, the entire stalk gradually drying up and becoming somewhat reddish. It is for this reason that the trouble is known in the Provinces of Bulacan, Laguna and Cavite as "Accip na Pula" or "Apayang Pula." The name in this case refers to the most noticeable symptom and not to the cause, the caterpillar. At bearing time the most characteristic indication of the attack of the pest is the presence of empty white heads or panicles. These heads can be easily pulled off as they have been severed by the caterpillar from the mother plants.

The moth is pale yellow in color with a black dot at the middle of each of the outer or front pair of wings, and is about one centimeter long and with a wing expanse of from 2 to 3 centimeters, depending upon the sex.

The moths lay their eggs in clusters usually on the upper surface of the leaves of the rice a few inches below the tip. They are brownish yellow in color because of the hair covering from the abdomen of the female. It is not difficult therefore

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[1] Issued formerly as Circular No. 159 of the defunct Bureau of Agriculture and Plant Industry Leaflet No. 7.

to see them on the leaves of the plants. The number of eggs in an egg cluster varies from 36 to 96, according to observations made by A. Rowan at the College of Agriculture, Los Baños, Laguna. Some farmers seem to believe that the caterpillars are engendered by the air rising from the soil instead of being born like other creatures and are greatly surprised when shown egg masses and told that the worms come from these.

The eggs hatch about nine days after they are laid. The newly hatched worms, which are less than 2 millimeters long and rather blackish, wander about and bore into the stalks of rice and feed within them, becoming pale yellow or light green after feeding for some time. In about two months, the caterpillars reach their full size, which is about 2.5 centimeters. They then transform into pupae, the resting stage, and remain as such for nine days, after which the moths emerge from the stalks thru holes made by the caterpillars before they pupate. The pupa is light brown and is about 1.5 centimeters long. The life cycle of the insect, then, from the time the eggs are laid to that when the moths emerge, is about three months.

Another species of rice borer is a white moth of about the same size as *Shoenobius incertellus*. It is known in science as the *Scirpophaga innotata*. It has essentially the same habits as the former.

## CONTROL MEASURES

The following methods may be employed to get rid of the rice borers described here:

1. Collecting the eggs and crushing them. This is the best way and is practised in Japan. The importance of this method can at once be appreciated when the fact is taken into account that there are on the average about 60 eggs to a cluster. The farmers should begin to look for the eggs in the seed bed. Instead of destroying the egg clusters they should be placed in a suitable container, such as a can or a bamboo tube. This should be placed in a pan of water to which kerosene has been added. The object is to allow the parasites that emerge to escape and starve out any rice borer larvae that may develop.

2. Collecting the infested stalks and burning them will also help to reduce the damage. Care should be taken to cut the stalks at the very base so as not to miss the worms.

3. Trapping the adult moths by means of light may also be tried. A lantern set in a pan or basin of water to which has been added kerosene sufficient to cover the entire surface with a

film of oil is best. The moths are attracted by the light, the more so when it is brighter, and fall into the basin and are drowned. This method involves some expense, however. Light traps should be used timely, that is, when moths are present and abundant and before they are spent or before they have laid all their eggs.

4. Clean culture should be widely practised by farmers. All grasses that may harbor the moth and which may serve as hosts should be destroyed. The rice stubbles should be destroyed so as to kill the pupae.

5. The more vigorous the plants the more they are able to resist the attack of the pest. The paddies should be thoroughly prepared so as to destroy all the weeds. Fertilization, if necessary, should be practised, and other essential requirements of the rice plants, such as sufficient supply of water, should be attended to. Selected seeds of high yielding varieties should be used.

6. In some places in the Philippines, as in Cebu, finely chopped derris (tublé) roots are scattered over the infested paddies. The toxic or poisonous substances present in the roots are dissolved in the water in the paddies and it is supposed that when the caterpillars, on coming in contact with the water, as when they swim from plant to plant, they are poisoned and killed. Athough the alleged effectiveness of this remedy has not been thoroughly investigated, yet this method is being included here so that in places where derris roots can be obtained in abundance the farmers may try it. It may also be employed against the "rice case worms" or caterpillars, locally known as "Accip na Pute" or "Apayang Pute" (Tagalog) and "Cutalo" (Ilocano) and in science as *Nymphula* sp. Derris dust or powdered derris roots may also be employed. Derris dust (analyzing or containing about 3 per cent rotenone) has been found effective by the writer against many insects including rice case worms and the migratory locusts, both hoppers and flyers. The use of derris dust has also been recommended for the rice bugs or "atangia" (see Farmers' Circular No. 30). One advantage of derris is that it can be handled and applied by farmers without danger of being poisoned—unlike arsenical compounds which should be handled with the utmost care.

# ILLUSTRATION

PLATE 1. The rice borer

FIG. 1. Egg mass on rice leaf.
2. Larva or caterpillar.
3. Rice stem cut open showing the caterpillar.
4. Pupa.
5. Adult moth.

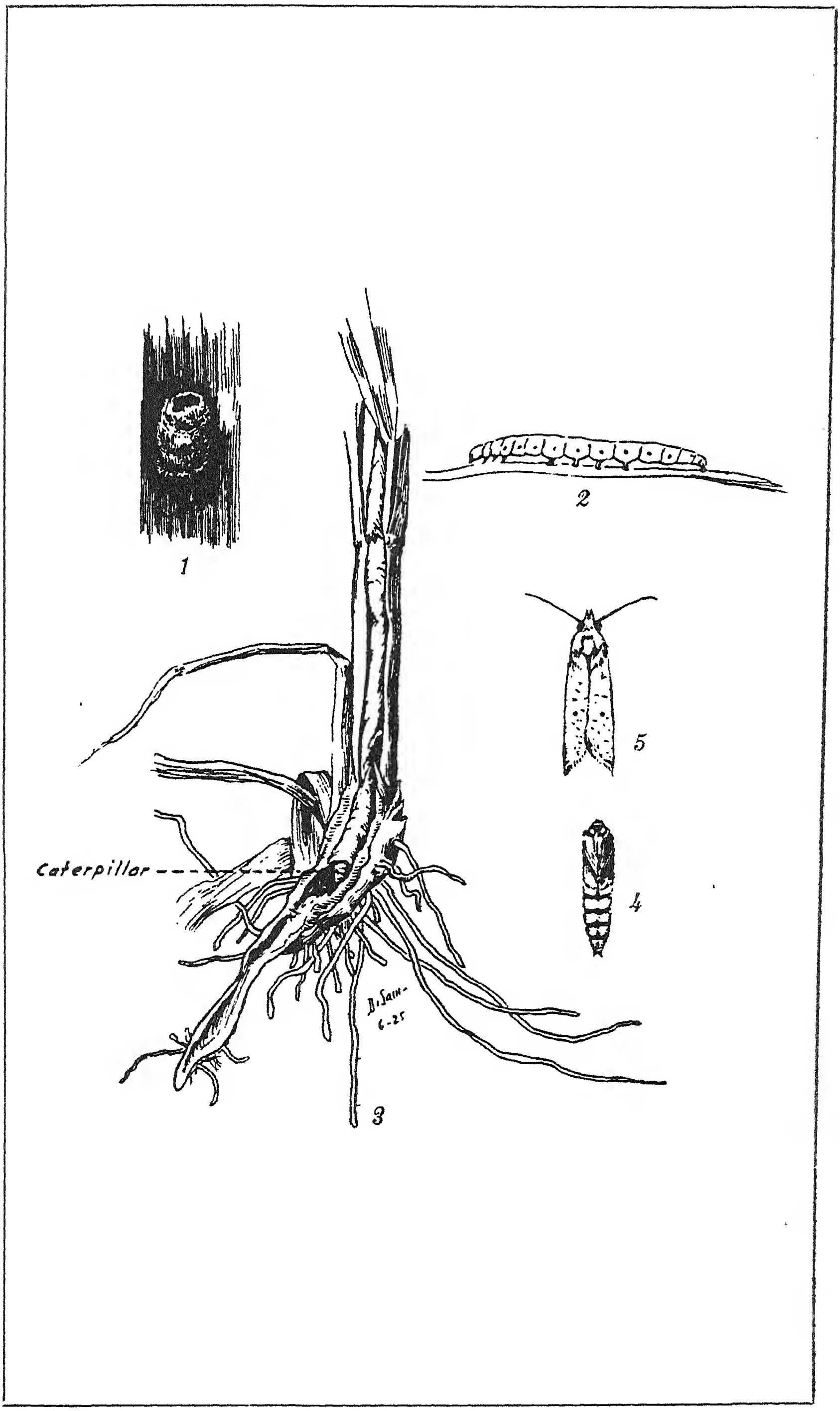


PLATE 1.

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DEPARTMENT OF PUBLIC WORKS AND COMMUNICATIONS

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MANILA

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*Chief, Publications Division*

Subscribed and sworn to before me this 24th of September, 1937, at Manila, the declarant having exhibited his cedula No. F–21005 issued at Manila on January 11, 1937.

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# INDEX

## A



## B

C



D

R